

Social Organization in the
Red Jungle Fowl (*Gallus gallus* subsp.)

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INTRODUCTION¹

Among birds, social organization based on aggressive behavior is both widespread and well documented. Although much of the information dealing with this facet of avian behavior is the result of studies on captive birds, field observations such as those reviewed by Collias (1944) and later by Allee (1950) indicate that these behavioral phenomena are not merely a reflection of artificial confinement.

With an extensive background of both descriptive and analytical information about the social organization of the common domestic fowl, a study of the hierarchal behavior of a closely-related species was desirable. The present investigation had a two-fold purpose: (1) to contribute to our

¹This investigation was supervised throughout by the late Professor Warder Clyde Allee whose deep interest, stimulation, and guidance was of the utmost benefit in the pursuit of this study. Particular recognition is given Dr. E. Ruffin Jones who offered encouragement and advice during the preparation of the manuscript, and accepted the responsibilities of acting chairman of my graduate committee. Aid from the following staff members of the Department of Biology is acknowledged: Drs. P. Brodkorb, J. C. Dickinson, J. Gregg, A. Grobman, and H. Wallbrunn. Dr. J. C. Driggers of the Department of Poultry Husbandry offered many helpful suggestions concerning care and breeding of the birds. All post-mortem examinations were made by the staff of the Poultry Diseases Laboratory. My wife, Hilda M. Banks, is due special mention for her moral and material contributions to this study, not the least of which included careful editing and typing of this manuscript.

knowledge of the hierarchal behavior of a previously unstudied group; (2) to compare this behavior with that of the related common domestic fowl. C. O. Whitman (1898) suggested the study of behavioral phenomena from the standpoint of phylogenetic descent. Recently, Lorenz (1950) has reiterated this point of view. The pioneer study of this type was that of Whitman on the Columbidae, published posthumously in 1919. Heinroth (1910) also followed the phylogenetic point of view in his behavioral analysis of the Anatidae. Behavioral studies of representatives of three closely-related genera of grouse by J. W. Scott (1950) are phylogenetic in nature. J. P. Scott (1950) compared the social behavior of wolves and dogs. The behavior of a number of invertebrates has been studied with the view of establishing phylogenetic relationships. The studies of Wheeler (1923) on a number of species of social insects, Petrunkevitch (1926) on spiders, Emerson (1938) on the phylogeny of nest construction in colonial termites, and Crane (1949) on the comparative behavior of salticid spiders, are noteworthy examples of investigations by students of invertebrate biology. The selection of a form closely related to the common domestic fowl for a study of social organization is in line with this approach.

Although the exact relationship between the Red Jungle Fowl and the common domestic fowl is not completely clear, the evidence presently available indicates that these forms are closely related. Speculation concerning the origin of domestic

breeds of poultry was first crystallized by Darwin (1868). Later, Tegetmeier (1873) reviewed the evidence and arrived at the same conclusions as had Darwin. The hypothesis presented in these reports was that all breeds of the domestic fowl Gallus gallus L. were developed from one of four wild species of the genus Gallus, namely the common Red Jungle Fowl known at that time as Gallus ferrugineus or Gallus bankiva.

The evidence on which both authors based this hypothesis include the following considerations: the Red Jungle Fowl is the only species of the genus that is common, wide-ranging, can be tamed, produces fertile offspring with common domestic fowls, and closely resembles in structure, plumage, and voice, the Game fowl which are considered as the most generalized domesticated breed. There are no indications, according to Darwin and Tegetmeier, that other living members of the genus Gallus, or an extinct form, either could or must necessarily have participated in this development.

Hutt (1949) summarizes a second hypothesis which involves all four wild species of Gallus in the development of the common domestic breeds. It is now known that hybrids between all species of the genus and domestic fowl are fertile. He further comments that the frequent repetition of Darwin's monophyletic hypothesis has led to its premature acceptance, and that it would appear that the problem awaits systematic breeding experiments before final judgement can be made.

In a study of protein composition of egg whites obtained from Red Jungle Fowl, designated simply as Gallus gallus, and the common domestic fowl, McCabe and Deutsch (1952) found a marked similarity between the two forms, a further indication of close taxonomic relationship.

According to Delacour (1951) there are five geographic races of the Red Jungle Fowl. All subspecies are well defined but, "The exact limits of distribution of the different subspecies . . . need more precision, and no doubt extensive zones of intergradation exist between them."

In an attempt to identify the race of Red Jungle Fowl with which the present report is concerned, a pair of skins was sent to the Museum of Comparative Zoology at Harvard College. The report of Mr. James Greenway, Jr., Curator of Birds, reads in part as follows: "The Red Jungle Fowl resemble Gallus gallus gallus (L.) and G. g. spadiceus (Bonaterre), races of Siam and Indo-China. . . . it is probably impossible to determine exactly the origin of these birds. There is no indication in the plumage of mixture with domestic stock."² The skins from which this estimation of the taxonomic status of our colony of Red Jungle Fowl, to be referred to as Gallus gallus subsp., were made are now deposited in the Florida State Museum, Gainesville, Florida.

²Personal communication, quoted with consent.

METHODS

The nucleus from which our colony of Red Jungle Fowl was developed consisted of two groups of birds, obtained on different dates. Both groups were representatives of one importation of Red Jungle Fowl into this area from a fancy-bird breeder in California. The first consisted of two adult cocks, one cockerel, five adult hens, and two pullets, received in September, 1951. In February, 1952, an additional stock of six pullets and thirteen cockerels was obtained. Further additions to the colony resulted from matings in our pens.

Increase in colony size through breeding between individuals of the two original groups followed three courses. Our main concern was to raise a sufficiently large number of Red Jungle Fowl to permit the study of groups of birds housed together in numbers comparable to those employed in studies of common domestic fowl. Therefore, eggs were collected and stored in a refrigerator for up to but not longer than seven days. These were then set in a small, 100-egg incubator. Following standard poultry husbandry techniques, the set eggs were kept at from 99-101° F, turned three to five times daily, and exposed to a humid environment, provided by finger bowls of water.

During the winter period of October 1951 to February 1952, fertility was low and hatchability also proved disappointing. Modifications in temperature of the incubator and feed of the breeding birds, during this interval, were not fruitful. The explanation for this poor reproductive capacity was not clearly indicated, although the early morning frosts, frequent in this area during the winter, may possibly have been responsible. During the spring, summer, and early fall of 1952 and 1953, artificial incubation for twenty-one days proved more successful and some sixty chicks were hatched. All incubator-hatched chicks were brooded indoors, in small, 25-chick brooders. They were fed a ration of commercial chick-starter mash and water. At four weeks of age, the chicks were vaccinated against fowl pox, tested for pullorum disease, and moved to a pen in the same area in which the adult flocks were housed. This pen was modified by isolating an area 6 x 4 feet with poultry netting. A 60-watt bulb, whose height above the floor could be controlled, provided the necessary heat. During this period, which lasted until the birds were from two to three months old, a ration of commercial chick-growing mash plus a small daily feeding of crushed grains was provided. Thereafter, the birds were assembled in various combinations, and their social behavior was observed.

A second breeding method followed was to allow a broody jungle hen to hatch out her clutch of five to eight eggs and brood the chicks in the pen or yard in which the

eggs were laid. For reasons which will be discussed in the observation section, this method was relatively unsuccessful in terms of increasing the colony size.

A modification of the above-described routine was to remove chicks to an electric brooder shortly after hatching. These were treated in a manner similar to chicks hatched in the incubator. Of the three methods, this one proved most successful. The hen-hatched chicks were easily reared to adulthood. One disadvantage of this method was that fewer chicks of the same age were produced as compared with the first method wherein eggs were collected over a period of up to seven days before being set in the incubator.

Early in the study, adult birds were housed in poultry range shelters. These were 8 x 10 feet in width and length, walled with poultry netting and roofed with corrugated tin. In addition, a 4 x 6 foot shelter with a wire-covered extension 3 x 20 x 6 feet in height, length, and width, respectively, was used to house temporarily the thirteen cockerels of the second group of Red Jungle Fowl referred to above. The latter house was used thereafter for surplus birds when these were present. In June, 1952, all birds except male flock 3 were moved to permanent wooden houses, each divided into two 8 x 10 foot pens.

Extending the length of each pen was a dropping board, 2 feet above the floor and $3\frac{1}{2}$ -feet wide. Six inches above the latter were two or three 2 x 4 inch perches. The

pens were also furnished with water pails, mash hoppers, and nests. Wood-shavings litter covered the dropping boards and pen floor. Each pen opened by a small door to an outdoor yard. The L-shaped yards were 20-feet wide and 38-feet long. Approximately 6 feet above the ground, 2-inch poultry netting served to enclose all outdoor yards from above.

The partition dividing each house into two pens was constructed partially of a wooden wall and a frame door with wire mesh covered with burlap completing the division. A hole, approximately one-foot square, was cut out of the burlap to afford a clear view of the pen floor; only the head of the observer was clearly visible to members of the flock undergoing observation.

Commercial poultry egg-laying mash and water were provided at all times. During observation periods, a mixture of whole grains composed of corn, wheat, and oats was dropped in a central area of the pen floor. Large, plastic wing badges with bold, black numbers on a yellow background proved excellent for rapid identification of the birds. Social interactions between individuals were recorded by writing down the particular wing badge number, and the type of aggressive-submissive behavior exhibited. However, a more expeditious and quantitatively accurate method of recording this type of social behavior, used by Banks and Allee (1954), was followed when possible. This technique consisted of recording by voice all observed interactions on a magnetic tape-recorder

and transcribing these data after the observation period. The advantage of such a recording method is obvious, and the voice of the observer had no apparent effect on the birds. Finally, slow-motion pictures of much of the hierarchal behavior observed in this study were taken.

The observation period took the following course. After placing the mixed grains on the floor of the pen to be studied, the observer took a position in the adjacent pen. If the latter were occupied by a flock, it was carefully stimulated to move out to the yard, and the yard door was closed. No attempt was made to force all members of the flock undergoing observation into their pen. Experience indicated that such a procedure could disrupt the normal flock behavior for a considerable period of time. Furthermore, it was found to be unnecessary to lock all individuals of an observed flock into their pen. Motivation for the grains was kept at a high level by feeding only during observation periods. The sounds of the grains being dropped on the floor was usually sufficient to attract all birds into the pen, providing the observer had taken his position in the adjoining pen. The observation recording period varied from 10 to 30 minutes.

In the present work the aggressive-submissive interactions between pairs of individuals were characterized by the following objective criteria: aggressive behavior manifested by pecking or threatening by a dominant; submissive

behavior evidenced by avoiding movements by the subordinate individual. The peck is an overt action wherein the aggressive individual strikes the contact-mate with the bill. These blows generally fall on the head and neck regions. Threats may be less obvious to the casual observer, but are characterized by Guhl (1953) as, ". . . undelivered pecks or instances in which the dominant bird raised its hackle or in an otherwise threatening manner caused the inferior to which this behavior was directed to avoid the threatening bird." Avoidance behavior, exhibited by a submissive individual, ranges from a mere dodging of the head to escape a peck to rapid and quite skillful flight.

Although the level of aggressive behavior is enhanced by the methods used in obtaining the data presented below, social interactions of the same type may occur in the absence of obvious competitive situations. A dominant bird may strike a subordinate while both are merely walking about the pen or yard. On the other hand, it is not the intent of this report to give the impression that the only activity to be seen in penned flocks of Red Jungle Fowl is the display of hierarchal behavior. Other types of activity not mentioned above and incidental to this study include such organizationally neutral behavior as preening, sand or dust bathing, roosting, random walking and scratching in the litter or soil. The Red Jungle Fowl is an extremely excitable bird. When it became necessary to handle the birds, for

example to move individuals from one pen to another, it was found most expedient to make such moves at night after the birds had gone to roost for a few hours.

OBSERVATIONS

The data to be discussed below are based on observations collected from February, 1952, to December, 1954, on the following groups: four female flocks, three male flocks, one flock composed of White Leghorn cocks, four heterosexual flocks, and one part-time heterosexual flock. The composition of each and the inclusive dates and hours of study appear below. A complete tabulation of aggressive interactions for each group is given, and the social organizations are illustrated by sociograms. Each flock is discussed briefly and pertinent observations noted.

SOCIAL HIERARCHY IN HEN FLOCKS

Flock 10A

Observations of the hierarchal behavior of this flock extended from November 24, 1953, to March 22, 1954, the group being studied on 74 days for a total period of 21 hours. A sociogram indicating the dominance-subordinance relationships of the nine hens comprising this flock at the end of the period is presented in Figure 1. The social organization exhibited is characteristic of the type based on peck-right dominance. When the birds are ranked according to the number of individuals dominated by a particular hen, the hierarchy

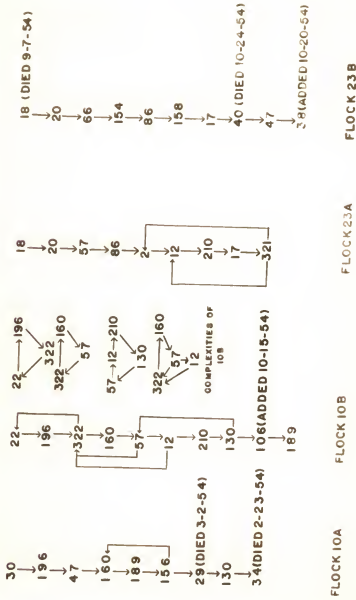


Fig. 1.--Sociograms of Hen Flocks

approaches a straight line except for the triangular relationships existing among hens 160, 189, and 156. A complete tabulation of the recorded social interactions appears in Tables 1 and 2. Observed social interactions, or pair contacts, among members of this flock totaled 2,067. The two forms of aggressive activity, pecking and threatening, each contributed about equally to the total.

TABLE 1
AGGRESSIVE INTERACTIONS IN FLOCK 10A:
NUMBER OF OBSERVED PECKS

Dominant Hens	Subordinate Hens									
	30	196	47	160	189	156	29	130	34	Total
30	..	93	60	48	53	37	45	37	10	383
196	52	23	47	38	12	19	17	208
47	28	13	21	16	26	15	119
160	24	3*	33	23	18	101
189	34	29	12	10	85
156	30	..	..	47	20	31	128
29	1*	..	1*	..	1*	4*	..	20	23	50
130	23	23
34	0

*Peck-order violation.

The most striking aspect of the hierarchal behavior of these hens is the rigidity characteristic of their relative dominance-subordinance positions. Of the total number of observed pecks, approximately one per cent fall into the category known as revolts, or peck-order violations as defined by Holabird (1955). Hen 160, on three occasions, pecked 156, a bird that was clearly its social dominant. One

other hen in this flock, 29, committed seven peck-order violations, one of which was directed to hen 30, another to 47, a third to 189, and the remaining four to 156. None of these instances of peck-order violations resulted in reversals of dominance. Each was quickly followed by a countering peck or threat by the dominant hen.

TABLE 2

AGGRESSIVE INTERACTIONS IN FLOCK 10A:
NUMBER OF OBSERVED THREATS

Dominant Hens	Subordinate Hens									Total
	30	196	47	160	189	156	29	130	34	
30	..	61	46	33	29	41	21	28	33	292
196	63	41	38	45	18	28	12	245
47	39	28	32	10	41	18	168
160	10	..	19	7	13	49
189	12	27	13	22	74
156	53	..	..	12	21	14	100
29	22	11	33
130	9	9
34	0

Those hens occupying highest ranks in the hierarchy were also observed to exercise the peck-right most frequently. Were the individuals in this flock to be ranked according to the number of pecks delivered, the resulting hierarchy would follow the same order as that presented in the sociogram in Figure 1, with the exception of hen 156, whose numerical record would place her above 189. With respect to the record of observed threats presented in Table 2, the trend is in the same direction as that of the pecks, but in this instance the

association between numbers of threats delivered and social status is not as close.

Three males were periodically introduced into this flock for breeding purposes. The effect of this procedure on the hierarchal behavior of the hens, and a report of the breeding behavior observed is presented later. However, the data presented above represent observations carried on in the absence of the three males.

Flock 10B

Observations of this flock extended from June 14, 1954, to November 19, 1954, for a combined total of 18 hours distributed over 107 days. Originally composed of nine hens, the flock was increased to ten individuals with the introduction of 106 on October 15, 1954. A tabulation of pecks and threats is presented in Tables 3 and 4, respectively. An examination of the structure of the organization as found in Figure 1, reveals a marked departure from a straight-line hierarchy. For the sake of clarity, the complex dominance-subordinance relationships revealed in the sociogram of flock 10B are illustrated individually in Figure 1. Two simple triangular relationships are found, one consisting of hens 22, 196, and 322, and the other of 322, 160, and 57. A third complication is that involving 57, 12, 210, and 130. The final deviation from a straight-line hierarchy is an extension of the second triangle referred to above, with the addition of 12, subordinate to 160 and 57, but dominant to 322.

The sociogram may be said to represent a geometrical type of peck order (Foreman, D. in litt.).

TABLE 3

AGGRESSIVE INTERACTIONS IN FLOCK 10B:
NUMBER OF OBSERVED PECKS

[illegible]

*Peck-order violation.

TABLE 4

AGGRESSIVE INTERACTIONS IN FLOCK 10B:
NUMBER OF OBSERVED THREATS

[illegible]

Hen 106 was arbitrarily added approximately four months after the flock was assembled. It should be noted that all resident hens except 189 won peck-right over 106. This fact is of interest for two reasons. At the time of introduction, 106 was four and one-half months old and therefore the youngest individual present. The dominance of 106 over 189 is contrary to findings to be reported later, on similar introductions wherein the younger of two individuals is generally found to be subordinate to the older of the contact pair. A second consideration is that members of an organized flock tend to win over singly-introduced strangers if the introduction occurs in the home pen of the organized flock. The explanation of the dominance of 106 over 189 rests on the fact that the latter became broody late in June and continued in that condition throughout the study.

One of the concomitants of broodiness in other birds, such as the common domestic hen and the pigeon, is a reduction in the secretion of gonadal hormones (Riddle and Bates, 1939). This reduction, if such did in fact occur in hen 189, was reflected in a decrease in aggressive behavior. Collias (1943) found that male hormone, as indicated by comb size, was a major factor in the ability of domestic hens to win initial contests. Such an explanation must remain provisional until endocrine studies are undertaken on the Red Jungle Fowl, but if such were the case, it would offer an interpretation for the success of 106, a young, newly-introduced hen,

in gaining dominance over 189, a fully-adult, long-time resident of the flock. Further support for this reasoning rests on the reversal of dominance-subordinance relations between 130 and 189. The latter held peck-right over 130 when both were members of flock 10A, and during the first week of observation of the present flock. After 189 became broody, 130 successfully challenged her dominance and executed the sole example of reversal in social status found in this study of hen flocks.

The stability of the hierarchy in Red Jungle Fowl hens is further demonstrated by the small number of peck-order violations witnessed in this flock. Hen 22 committed four violations against 322, none of which resulted in alteration of the hierarchy. In addition, 57 pecked 130, her social dominant, on one occasion. This peck-order violation was quickly retaliated by 130. Of the total number of observed pecks recorded during the 18 hours in which flock 10B was studied, only about 0.4 per cent could be classified as being counter to the social organization.

The correspondence between social status and observed aggressive activity is less clear in this flock than it was in flock 10A. The trend, however, remains in the direction of more frequent use of the peck-right in those hens holding high social rank. An interesting exception to this tendency is shown by the record of hen 106. Though dominant only to 189, the total number of pecks delivered by 106 compares

favorably with that of 130 and 210, both of which were dominant to three individuals.

Flock 23A

A total of 21.2 hours, distributed over 65 days was spent in the observation of this flock. Study began on August 9, 1953, and extended to November 2, 1953. A tabulation of the social interactions witnessed is presented in Tables 5 and 6 for pecks and threats, respectively. A sociogram of the hierarchy so determined appears in Figure 1. It will be noted that this flock is organized in a simple, straight-line hierarchy, except for the dominance of 321 over 2 and 12. Aside from these deviations, the hierarchal behavior of these hens is straight-forward and typical of the peck-right form of social organization. No peck-order violations were observed.

TABLE 5

AGGRESSIVE INTERACTIONS IN FLOCK 23A:
NUMBER OF OBSERVED PECKS

Dominant Hens	Subordinate Hens									Total
	18	20	57	86	2	12	210	17	321	
18	..	152	97	38	26	23	15	43	21	415
20	103	76	22	27	34	17	18	297
57	23	29	29	58	18	78	235
86	23	11	41	14	17	106
2	32	21	11	..	64
12	18	27	..	45
210	13	28	41
17	31	31
321	41	22	..	..	..	73

TABLE 6

AGGRESSIVE INTERACTIONS IN FLOCK 23A:
NUMBER OF OBSERVED THREATS

Dominant Hens	Subordinate Hens									Total
	18	20	57	86	2	12	210	17	321	
18	..	19	39	11	18	21	33	30	25	196
20	42	37	47	40	18	28	33	245
57	29	17	39	41	18	26	170
86	38	29	33	16	52	168
2	31	28	41	..	100
12	22	47	..	69
210	28	17	45
17	42	42
321	37	21	..	..	..	58

The alpha, or highest-ranking individual, 18, the oldest female of the colony, exercised her peck-right vigorously and persistently, and contributed approximately one third of the total number of pecks recorded for the flock. The aggressive behavior of 18 was of such a severe nature that some subordinate hens responded to her in an ambiguous manner. She was the only individual to which subordinates gave the "sex crouch" as a manifestation of submissive behavior. This behavior pattern is frequently seen in receptive hens in the presence of a male and consists typically of a lowering of the body into a squatting attitude, wings raised and held away from the body; neck, head, and beak extended horizontally above the floor. The sex crouch was exhibited by 2, 12, 210, and 17 in interactions with 18. Although extremely aggressive, 18 did not appear masculinized, i.e., her comb was no larger than that of other hens

and she produced and incubated normal clutches of eggs.

Flock 23B

Study of the hierarchal behavior of flock 23B extended from June 15, 1954, to November 23, 1954, for a total of 18.1 hours of actual watching and recording of behavior distributed over 109 days. Tabulations of the aggressive behavior recorded appear in Tables 7 and 8 for pecks and threats, respectively. A sociogram of the organization of this flock, illustrated in Figure 1, reveals a straight-line dominance-subordinance hierarchy. The alpha hen, 18, held her position until September 7, at which time she died of chronic pullet disease. It is interesting to note, in this respect, that although 18 became distinctly less vigorous in all aspects of her observed behavior, between the time this flock was assembled and her death, there were no known peck-order violations directed to 18. During June, 40 was observed to respond to the aggressive approaches of 18 by exhibiting the sex crouch on two occasions. Following the death of 18, the second-ranking individual in the hierarchy, 20, became alpha hen.

Approximately one month before observation of this flock was discontinued, 38, a five-month-old pullet was introduced. In this instance, the young, newly-introduced individual was defeated in pair-contacts with all resident flock members and assumed omega status in the hierarchy, the normal,

expected outcome of such a procedure. Hen 40 died of lymphomatosi s on October 24, 1954. Although she was observed in pair-contact with 38 on only eight occasions 40 was clearly dominant to 38, the newly-introduced pullet.

TABLE 7

AGGRESSIVE INTERACTIONS IN FLOCK 23B:
NUMBER OF OBSERVED PECKS

[illegible]

TABLE 8

AGGRESSIVE INTERACTIONS IN FLOCK 23B:
NUMBER OF OBSERVED THREATS

[illegible]

Relative Social Status of Hens Together in Two Flocks

Twelve of the twenty-six hens used in this study were members of two flocks. The hierarchal behavior of these individuals may be viewed from two aspects: (a) the relative dominance-subordinance relationships of those hens that were both members of the same two flocks, and (b) the status of each such hen in the hierarchy of the two flocks of which it was a member.

Table 9 presents a list of birds that were residents of the same two flocks, and indicates the dominance-subordinance relationships between both individuals in each flock. It is clear from this analysis that once dominance becomes established between any pair of individuals, transfer to another flock or the introduction of new hens into the same pen has no effect on the dominance-subordinance relationships previously determined. The one exception is the case of 189 and 130. When they were members of flock 10A, 189 was dominant to 130. Approximately three months later, when both individuals were members of flock 10B, 130 became dominant over 189. This reversal in social status has been discussed previously.

It will be noted that only eleven hens are listed in Table 9 as being members of two flocks. The twelfth hen, 47, was a member of flocks 10A and 23B, the only individual so arranged.

TABLE 9

RELATIVE DOMINANCE-SUBORDINANCE POSITIONS
OF HENS TOGETHER IN TWO FLOCKS^a

First Flocks	Second Flocks
10A	10B
196 > 160	196 > 160
196 > 189	196 > 189
196 > 130	196 > 130
160 > 189	160 > 189
160 > 130	160 > 130
189 > 130	130 > 189 ^b
23A	23B
18 > 20	18 > 20
18 > 86	18 > 86
18 > 17	18 > 17
20 > 86	20 > 86
20 > 17	20 > 17
86 > 17	86 > 17
23A	10B
57 > 12	57 > 12
57 > 210	57 > 210
12 > 210	12 > 210

^a > = dominant over.

^b Reversal.

The status of each bird in the hierarchy of the two flocks of which it was a member is presented in Table 10. The relative position of each hen is given in terms of numbers of individuals dominant or subordinate to a particular bird. In general, there are no striking differences in the status of a given hen in the A, or first set of flocks, and the later-organized B flocks. The records of 189 and 47 are exceptional in this respect. The case of 189 has already been discussed, and it is of interest here merely to note

that when a member of flock 10A, 189 ranked midway in the organization of that flock. Later, when a member of 10B, 189 fell to omega status.

TABLE 10
SOCIAL STATUS OF HENS WHICH WERE MEMBERS
OF TWO FLOCKS

Hen	Flock	No. Dominant to	No. Subordinate to	Flock	No. Dominant to	No. Subordinate to
196	10A	7	1	10B	8	1
189	10A	4	4	10B	0	9
160	10A	4	4	10B	6	3
18	23A	8	0	23B	8	0
20	23A	7	1	23B	8	0 or 1 ^b
86	23A	5	3	23B	4 or 5 ^a	3 or 4 ^b
17	23A	1	7	23B	2 or 3 ^a	5 or 6 ^b
57	23A	6	2	10B	6	2
210	23A	2	6	10B	3	6
12	23A	3	6	10B	5	4
47	10A	6	2	23B	0 or 1 ^a	7 or 8 ^c

^aAfter addition of 38.

^bBefore death of 18.

^cBefore death of 40.

The case of 47 is also worthy of note. When a member of 10A, 47 was dominant to six hens and subordinate only to the alpha and beta members of that flock. On being transferred to 23B, 47 lost initial encounters with all flock members, becoming omega hen of the organization. When 38 was added to 23B, late in the study, 47 won peck-right over 38. This last observation lends support to the generalization that strange individuals added singly to an organized flock tend to lose initial pair-contacts with resident hens.

The Effect of Home Territory on Social Status

Table 11 illustrates the composition of the second set, or "B" flocks. Flock 10B was made up of four birds that had been members of 10A. Hens 196, 160, 130, and 189 had long experience with the pen in which they were housed. Into this pen, 57, 12, and 210 from flock 23A were introduced. The remaining members of 10B, 22, 322, and 106, were transferred from a surplus, previously unobserved group. To the last six hens, the pen housing 10B constituted a physically strange area. All but 106 were introduced into pen 10B on the evening before observation of this flock was begun.

TABLE 11

FLOCK REORGANIZATION SCHEME*

Flock 10B		Flock 23B	
Home Pen of:		Home Pen of:	
196 > 57, 12, 210, 322, 106		18 > 66, 154, 158, 40, 47	
160 > 57, 12, 210, 106		20 > 66, 154, 158, 40, 47, 38	
130 > 57, 106		86 > 158, 40, 47, 38	
189 > none		17 > 40, 47, 38	
Introduced into 10B from 23A:		Introduced into 23B from 10A:	
57 > 189		47 > none	
12 > 130, 189			
210 > 130, 189			
Introduced into 10B from Surplus Pen:		Introduced into 23B from Surplus Pen:	
22 > 196, 160, 130, 189		66 > 86, 17	
322 > 189		154 > 86, 17	
106 > 189		158 > 17	
		40 > none	
		38 > none	

*See text for explanation. Hens underlined were long-time residents of the pen. > = dominant over.

Flock 23B was similarly composed of four hens that as members of 23A had long experience with the pen. These were 18, 20, 86, and 17. One bird, 47, was introduced from 10A and the remaining five were transferred from the unobserved surplus flock. All birds to which pen 23B was an unfamiliar area were introduced as a group on the same evening, except for hen 38, which was added about one month before observation of this flock was discontinued.

It is of interest to examine the resulting hierarchies of 10B and 23B to determine whether hens to whom the pen was a familiar area were more successful in winning peck-right than were those individuals to whom the pen constituted a strange territory.

In flock 10B, 22 won dominance over all four hens that were long-time residents in the pen. Of the remaining introduced birds, 12 and 210 won over two long-time residents, and 57, 322, and 106 over one. Among the hens with long experience in this pen, 196 won over five introduced birds, 160 over four, and 130 over two. 189 failed to gain peck-right over any of the introduced birds.

In flock 23B only three of the introduced birds gained dominance over long-time residents. Hens 66 and 154 won over 86 and 17, and 158 became dominant to 17. Three birds, 47, 40, and 38, failed to win over any of the pen-experienced individuals. Both 18 and 20, long-time residents of the pen, won over all introduced birds. (18 died before 38 was added

to the flock.) Hens 86 and 17 were moderately successful in winning over introduced birds.

The trend indicated by these data is in the direction of success in winning crucial initial contacts associated with familiarity or long-time residence in the given pen. The exceptions (particularly that of 22 in flock 10B) and the small number of cases prevent a generalization. From information to be reported later, it is known that strange hens introduced singly into organized flocks invariably lose to most or all resident hens. The fact that in the present instance, birds were added in considerable numbers on one night may explain the failure of long-time residents to benefit from the advantage of familiarity with the pen and win dominance over all introduced birds.

SOCIAL ORGANIZATION IN JUNGLE FOWL COCKS

Flock 3

This flock was composed of twelve cockerels and one cock. The former were part of a larger group received early in February 1952, and were three and one-half months old at this time. The latter was the oldest male of the colony; he was a mature adult when obtained in September 1951. During the time in which the observations to be discussed were collected, this flock was housed in a 4 x 6 foot frame shelter, one side of which extended into a wire-covered runway 3 x 20 x 6 feet in height, length, and width, respectively.

Before describing the social hierarchy of this group, some comment regarding its general behavior is pertinent. The male Red Jungle Fowl is highly pugnacious and excitable. The combination of these two complex characteristics, associated with the small living quarters in which they were kept, made for an extremely sensitive group. Particular care was exercised in approaching the pen, and in providing the mixed grains about which aggressive-submissive interactions were focused. A considerable amount of aggressive activity was observed in the runway, some distance from the feeding area. As in flocks of Red Jungle Fowl hens, hierarchal behavior was primarily exhibited in pecking, threatening, and avoiding reactions. In addition to these, "waltzing" and crowing

contributed to the overall picture of a highly aggressive social organization. These latter factors will be discussed below.

Flock 3 was observed closely from February 18 to August 12, 1952, for a total of 31.7 hours distributed over 127 days. A tabulation of observed pecks and threats appears in Tables 12 and 13, respectively. Three sociograms of the hierarchy appear in Figure 2. Several aspects of these data merit consideration. Of a total of 2,833 observed pecks, 170 or 6 per cent fall into the peck-order violation category. The dominance-subordinance stability, shown so clearly in the female hierarchy presented earlier, is in the present case incomplete, as evidenced by five instances of reversal in dominance. In addition, dominance-subordinance relationships between four pairs of cockerels were of a recurrent nature. These latter are indicated in the sociograms by broken lines.

The structure of the hierarchy varied during the study period, but can be characterized as nonlinear, i.e., containing complicated peck-right relationships. A sociogram for three divisions of the total study time is helpful in depicting the new dominance orders created by the following reversals in social status: 11 over 4 (March 6), 8 over 4 (April 24), 6 over 12 (May 13), 12 over 3 (June 11), and 4 over 7 (July 28). In each of these cases, the cockerel over which a reversal in dominance was gained was clearly dominant to the socially-mobile bird prior to the reversal. Subsequent observation

indicated no peck-order violations by the formerly dominant individual against the new dominant of a given pair.

TABLE 12
AGGRESSIVE INTERACTIONS IN FLOCK 3:
NUMBER OF OBSERVED PECKS^a

Dominant Cocks	Subordinate Cocks													Total
	1	2	5	3	12	4	8	6	9	7	10	11	13	
1	..	38	54	66	54	57	42	45	66	30	99	84	42	677
2	15	39	42	21	24	18	12	27	24	24	13	259
5	18	39	69	42	12	42	30	48	18	15	333
3	..	8*	..	..	45	63	21	12	33	21	18	39	42	302
12	<u>23</u>	..	27	33	15	33	21	12	17	31	212
4	8*	..	..	..	15	9*	36	19	17	10	20	134
8	13*	..	24	<u>38</u>	..	27	17	<u>10*</u>	14	18	31	192
6	..	2*	..	..	43	28	4*	..	36	42	33	24	28	240
9	10*	..	<u>14*</u>	4*	7*	..	..	27	10	18*	39	129
7	3*	31	48	26	18	..	18	..	21	18	10	193
10	8*	3*	7*	11*	4*	6*	..	9	13	61
11	<u>38</u>	..	2*	33	..	..	..	18	91
13	<u>10*</u>	..	..	..	..	..	..	..	10

^aUnderlining indicates reversals.

*Peck-order violation.

This situation stands in marked contrast to that presented by the recurrent reversals in dominance relations between 7 and 3, 9 and 7, 12 and 7, and 8 and 12. Table 14 presents a summary of the exchange of dominance between these pairs of cockerels. For the sake of clarity, one series of reversals will receive comment with the implication that all followed the same general course.

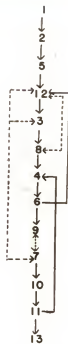
From February 18 to April 10, male 9 was observed in pair-contact with 7 on sixteen occasions. In every instance, 9 appeared clearly dominant to 7. However, on April 11 an unobserved reversal had occurred, and between this date and June



2-18T03-5



3-6T05-14



5-15T08-12-54

Fig. 2.--Sociograms of Male Flock 3

20, 7 exercised peck-right over 9 in eighteen different pair-contacts. The study period of June 21 revealed a second reversal between this pair, with 9 again in the dominant position. Eleven social interactions were observed between 9 and 7 from June 21 to August 12. In every case, 9 was the dominant member of the contact pair.

TABLE 13
AGGRESSIVE INTERACTIONS IN FLOCK 3:
NUMBER OF OBSERVED THREATS*

Dominant Cocks	Subordinate Cocks														Total
	1	2	5	3	12	4	8	6	9	7	10	11	13		
1	..	12	18	7	19	23	14	16	9	15	17	11	26	187	
2	21	10	11	14	17	8	4	12	10	11	17	135	
5	12	18	14	10	11	17	8	9	16	13	128	
3	14	19	8	5	12	8	17	9	20	112	
12	<u>11</u>	..	15	19	9	18	11	6	4	14	107	
4	18	..	8	<u>14</u>	10	5	18	73	
8	17	<u>21</u>	..	7	12	..	9	7	11	84	
6	<u>13</u>	..	..	..	11	14	8	6	14	66	
9	7	11	..	9	22	
7	14	21	8	11	12	6	..	5	3	12	82	
10	9	7	16	
11	<u>12</u>	..	..	7	..	..	..	8	27	
13	0	

*Underlining indicates reversals.

A prominent aspect of the social behavior exhibited by this group was the display of waltzing or strutting. Domm and Davis (1948) expressed the idea that the waltz is used by domestic roosters as a method of sex recognition. This matter is discussed later in the section on male mating behavior. The display of waltzing behavior by Red Jungle Fowl hens in initial pair-contests with other hens indicated that the waltz may also be an expression of aggressive behavior.

TABLE 14

RECURRENT REVERSALS IN DOMINANCE
RECORDED IN FLOCK 3

Dominant Cock	Subordinate Cock	Inclusive Dates
7	3	2/18 to 2/24
3	7	2/25 to 3/14
7	3	3/15 to 5/2
3	7	5/3 to 8/12
9	7	2/18 to 4/10
7	9	4/11 to 6/20
9	7	6/21 to 8/12
12	7	2/18 to 3/2
7	12	3/3 to 5/8
12	7	5/9 to 6/4
7	12	6/5 to 8/12
8	12	2/18 to 4/15
12	8	4/16 to 4/28
8	12	4/29 to 6/3
12	8	6/4 to 8/12

That the waltz was definitely an aspect of aggressive behavior in the cockerel flock under discussion may be seen from the data presented in Table 15. This tabulation is arranged so that those birds displaying the waltz are listed in the left-hand column; those to which the waltz is directed appear in the upper row, and the figures indicate the number of times the waltz was observed between a given pair of males. There are 78 possible unidirectional dominance relationships in this flock of thirteen males. In all except three pairs, dominants were observed to address the waltz to subordinates. There were only two instances of waltzing contrary to the social hierarchy as determined by pecking. Male 11 was observed to waltz 6 on two different occasions, and the latter clearly

held peck-right over the former. Although the number of waltzes observed was about half that of observed pecks, the evidence is such that if the birds were arranged according to the "waltz-right," the resulting organization, with the exceptions noted above, would be identical to that based on peck-right.

TABLE 15

AGGRESSIVE INTERACTIONS IN FLOCK 3:
NUMBER OF OBSERVED WALTZES^a

Dominant Cocks	Subordinate Cocks														Total
	1	2	5	3	12	4	8	6	9	7	10	11	13		
1	..	12	10	7	28	18	30	19	38	25	17	43	38	285	
2	3	10	11	7	12	21	27	18	15	33	17	174	
5	2	1	7	..	15	19	16	23	83	
3	21	4	11	15	21	4	18	30	14	138	
12	<u>14</u>	..	2	18	8	3	7	12	8	29	101	
4	3	..	7	<u>2</u>	17	8	12	49	
8	14	8	..	4	9	..	12	11	6	64	
6	<u>17</u>	<u>6</u>	..	..	2	1	1	4	3	34	
9	6	2	..	5	13	
7	7	5	15	5	..	12	..	3	4	10	61	
10	2	11	13	
11	<u>13</u>	..	2*	27	..	..	..	7	49	
13	0	

^aUnderlining indicates reversals.

*Waltz in violation of peck-order.

Mention has been made of crowing in this flock as a manifestation of aggressive behavior. In general, subordinate males were threatened while crowing, if a dominant were near. The peck-order was dramatically illustrated many times by the abrupt suspension of an incomplete crow given by a low-ranking cockerel when approached by a belligerent dominant individual.

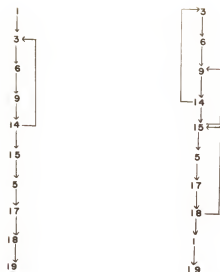
A final item of interest was the absolute dominance of 1, the oldest cock, over all other flock members. This dominance was exercised frequently and vigorously. At times during observation periods, it appeared that 1 expended more effort in pecking and waltzing his subordinates than he did in feeding.

Flock 24A

This group of ten mature Jungle Fowl cocks was assembled on the evening of November 12, 1952. Five of the males had been under observation when they were members of flock 3. The remaining five were previously unobserved. Study of hierarchical behavior began on the next day, and was continued until March 20, 1953, for a total of 26 hours distributed over 89 days. During the first week, although few social interactions were noted, it was apparent that many contests for the establishment of peck-right were taking place. All but 1 and 3 showed evidence of fighting in the form of wounds on comb and wattles. The flock, which generally stayed in the outdoor yard, was easily disturbed by the presence of the observer in the adjoining pen. Based on experience with hens, no effort was made to force the cocks into the pen. Deprivation of grains in addition to increasing familiarity with the pen were factors which undoubtedly helped to diminish the negative response of the birds to the pen when observations were being recorded, and during the second week the cocks entered the pen and fed readily.

A tabulation of observed pecks and threats is presented in Tables 16 and 17, respectively. Two sociograms illustrating the organization in this flock appear in Figure 3. This group resembles flock 3 in the large number of peck-order violations. There were ten complete reversals in dominance, eight of which involved cock 1. It will be recalled that 1 was the despotic alpha cock of flock 3. Soon after adequate records were collected it was clear that 1 was also the top-ranking male in this group. It was therefore of great interest to note that 1 lost peck-right to 14 on January 19. This reversal was not witnessed but inferred from wounds on both 1 and 14. That 1 had been defeated was equally obvious from the complete change in his behavior and posture. By January 28, all other flock-mates except 19 were observed in interactions with 1; all were dominant over this former alpha cock. No interactions were witnessed between 1 and 19, the omega individual. From the above-mentioned date until study of this flock was discontinued, 1 was a disassimilated member of the organization. He rarely entered the pen during observation periods when grains were made available, and on those few occasions, he was chased out to the yard by a dominant.

The disruption in the hierarchy discussed above had a general unstabilizing effect on the flock as a whole. The majority of peck-order violations were noted during the period between the first reversal of 14 over 1 on January 19 and the witnessed reversal of 15 over 1 on January 28. Two days later,



BEFORE REVERSALS

AFTER REVERSALS

Fig. 3.--Sociograms of Male Flock 24A

15 succeeded in gaining peck-right over 9. Finally on February 12, another reversal occurred that resulted in the dominance of 18 over 15.

TABLE 16

AGGRESSIVE INTERACTIONS IN FLOCK 24A:
NUMBER OF OBSERVED PECKS^a

Dominant Cocks	Subordinate Cocks										
	1	3	6	9	14	15	5	17	18	19	Total
1	..	23	18	38	17	20	49	32	10	8	215
3	17	..	15	22	8*	37	11	28	20	17	175
6	10	..	..	18	24	36	19	31	43	21	202
9	21	..	..	..	42	13	17	33	18	38	182
14	43	47	3*	10*	..	31	2*	28	48	16	228
15	18	7*	..	28	..	..	27	16	17	24	137
5	15	..	3*	4*	33	..	..	10	9	18	92
17	10	..	6*	..	..	10*	..	..	7	12	45
18	4	..	..	..	..	22	..	..	..	32	58
19	..	..	..	1*	..	4*	..	..	..	..	5

^aUnderlining indicates reversals.

*Peck-order violation.

TABLE 17

AGGRESSIVE INTERACTIONS IN FLOCK 24A:
NUMBER OF OBSERVED THREATS*

Dominant Cocks	Subordinate Cocks										
	1	3	6	9	14	15	5	17	18	19	Total
1	..	12	18	11	10	19	9	8	15	7	109
3	<u>21</u>	..	11	5	..	2	12	17	8	11	66
6	<u>17</u>	..	..	14	19	4	9	8	12	9	75
9	<u>24</u>	..	..	..	11	15	18	7	6	14	71
14	<u>11</u>	19	..	..	..	14	..	5	9	8	55
15	<u>15</u>	..	..	<u>8</u>	..	..	12	9	7	6	42
5	<u>18</u>	..	..	..	12	..	..	12	8	2	34
17	<u>23</u>	..	..	..	..	..	..	..	5	11	16
18	<u>12</u>	..	..	..	..	<u>4</u>	..	..	..	15	19
19	..	..	..	..	..	..	..	..	..	..	0

*Underlining indicates reversals.

Some waltzing was observed in this flock but the small number of such occurrences precludes an estimation of its hierarchal effects. In contrast to flock 3, a large number of incipient mating approaches were witnessed. In these instances the cock seen attempting to mount was always dominant to the contact-mate. Mounting attempts rarely followed a waltz by the dominant. The general procedure was for the mounting individual to approach from behind, grab and/or peck the comb of the subordinate cock while placing one foot on the back or saddle of the latter. These observed attempts were never successful. The subordinate cock was never seen to crouch, but always eluded the dominant. These comments are based on thirty-three witnessed homosexual mating attempts.

Prevention of the crowing of subordinates by dominant members of the organization was frequent, but the larger living quarters in which this flock was housed, compared with that of flock 3, enabled low-ranking cocks to crow.

Flock 24B

A third group of ten adult male Jungle Fowl was assembled for study. Two individuals, 1 and 19, had been members of the previously discussed flock 24A, and their behavior in a sex-segregated group was well known. The remainder had been observed while members of heterosexual flocks. The hierarchal behavior of this group was studied from June 23 to October 17, 1953, for a total of 22 hours extending over 81 days. A tabulation of pecks and threats recorded during this interval is

presented in Tables 18 and 19, respectively. Two sociograms depicting the social organization appear in Figure 4. A number of peck-order violations were committed by five members of this flock. Also noteworthy were five instances of reversal in dominance, the first reversal occurring shortly after study of this group began. Between June 23 and July 2, 94 exercised peck-right over 21 on seventeen occasions. There were no observed peck-order violations by 21 against 94 until July 3, when 21 staged a revolt that developed into a fight lasting five minutes. This hard-fought encounter resulted in the submission of 94, and from that time until study was discontinued 21 was clearly dominant over 94.

TABLE 18
AGGRESSIVE INTERACTIONS IN FLOCK 24B:
NUMBER OF OBSERVED PECKS^a

Dominant Cocks	Subordinate Cocks										Total
	68	94	21	56	24	74	97	19	266	1	
68	..	14	33	18	16	38	29	14	38	21	221
94	<u>28</u>	..	31	43	27	46	29	33	28	17	282
21	..	<u>17</u>	..	34	47	38	17	27	16	33	229
56	..	<u>10*</u>	..	..	38	<u>18</u>	24	22	18	42	172
24	..	3*	..	7*	..	<u>58</u>	37	22	17	11	155
74	26	<u>18</u>	..	38	30	41	26	179
97	2*	..	8*	..	<u>4*</u>	<u>22</u>	..	32	10	17	95
19	10	21	31
266	2*	..	3*	..	6*	..	..	13	24
1	8*	..	..	..	..	..	8

^aUnderlining indicates reversals.

*Peck-order violation.

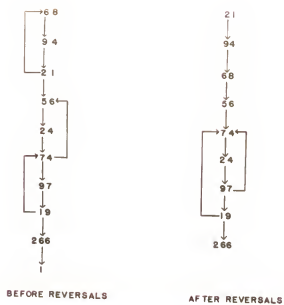


Fig. 4.--Sociograms of Male Flock 24B

TABLE 19

AGGRESSIVE INTERACTIONS IN FLOCK 24B:
NUMBER OF OBSERVED THREATS*

Dominant Cocks	Subordinate Cocks										Total
	68	94	21	56	24	74	97	19	266	1	
68	..	18	19	23	14	21	11	7	5	29	147
94	<u>23</u>	..	12	15	10	7	9	11	8	41	136
21	..	<u>19</u>	..	12	8	4	17	9	3	13	85
56	18	<u>12</u>	9	7	12	18	76
24	<u>13</u>	4	9	5	12	43
74	14	<u>8</u>	..	9	12	6	9	58
97	10	7	15	32
19	4	11	15
266	17	17
1	0

*Underlining indicates reversals.

Four other reversals occurred, none of which were witnessed. In these instances, the abrupt changes in dominance-subordination relationships between the individuals involved were quite marked. A tabulation of the reversals appears in Table 20.

TABLE 20

REVERSALS IN DOMINANCE IN FLOCK 24B

Reversal	Date
21 over 94	July 3
94 over 68	September 18
56 over 74	September 24
97 over 74	October 2
74 over 24	October 8

It is of interest to follow the history of 1, the deposed alpha cock of flock 24A. After his decline in status, described previously, 1 became extremely submissive, and

evaded flockmates constantly. When the present flock was organized, 1 was clearly omega and was notably harassed by all. This individual was completely unassimilated into the flock, and the degree to which flockmates focused aggressive behavior on 1 was demonstrated by the death of this male on September 25. Before the observation period of that date commenced, 1 was discovered in the pen in the following condition: head and neck completely denuded of feathers, eyes pecked out, and most of the tail feathers missing. The indications are that the debilitating effects of inanition and constant avoidance maneuvers allowed some or all flockmates to "gang-up," and the physical alterations observed on 1 are thought to have been made while he was alive.

Waltzing by dominant cocks was not prominently observed. There were few instances of mounting attempts in this group. Prevention by dominants of crowing by low-ranking individuals occurred frequently, but the latter were observed to crow while in the yard.

In summary, close study of three penned flocks of Red Jungle Fowl males reveals the existence of social organization based on peck-right dominance. In the present groups, the structure of the organization as illustrated in sociograms is of the nonlinear type. Contrary to the condition found in flocks of hens, a marked tendency toward instability in dominance-subordination relationships is noted. Some lack of rigidity in social status is manifested by frequent peck-order

violations and reversals.

A total of twenty complete reversals in dominance is recorded. In addition, a relatively rapid exchange of dominance between four pairs of cockerels is observed in flock 3. The recurrent reversals recorded in the cockerel flock may have been a reflection of the relatively small quarters in which this group was housed. Social interactions are enhanced under such conditions, and those factors responsible for stability of inter-individual relationships, such as rapid recognition of the contact-mate, become strained, with the results noted previously.

The prominent display of waltzing by dominants in the cockerel flock is not readily accounted for. This behavior, although present, was relatively inconspicuous in the two cock flocks. That the age factor was important cannot be entirely dismissed, but it should be recalled that 1, the despotic alpha individual of the flock was a completely mature adult and his aggressive behavior included the frequent display of waltzing to all subordinates. Another variable was the larger pen and yard that housed the adult groups. Why this increase in space per individual should lead to a marked diminution in waltzing by dominant cocks is not clear and this phenomenon merits further study.

It should be stressed that a bare tabulation of social interactions gives an incomplete picture of the dynamics of the hierarchy in these flocks. The disadvantages accruing to

low rank can be appreciated only after one watches male flocks in action about the feeding area. Submissive individuals are continuously driven away from the feed. Access to water is also difficult for low-ranking males. Although most cocks perch wing to wing at night, a few low-ranking individuals roost alone. Prevention by dominants of the normal vocalizations of subordinate cocks is a further indication of the vigorous type of social organization displayed by these birds. Finally, the dysgenic effects induced by the pugnacity of these birds is quickly documented by the fact that ten low-ranking cocks had either completely lost vision in one eye, or were apparently blinded as a direct result of fighting.

SOCIAL ORGANIZATION IN WHITE LEGHORN COCKS

With the view of collecting first-hand information that could be used in a general comparison of domestic and Jungle Fowl males, a flock of fifteen White Leghorn roosters, approximately three years old, was assembled. This group, designated flock 21, was studied at three different intervals. After the first period, which extended from November 25, 1952, to March 9, 1953, the flock was unobserved until July 1, 1953, at which time the number of individuals was reduced to ten. This group was closely observed from July 1 to October 23, 1953. A third set of records of the same ten cocks was obtained from April 2 to June 4, 1954. The three sets of data are referred to as 21A, 21B, and 21C, respectively. Total observation time for this group was 37.5 hours distributed over 151 days.

Aggressive interactions recorded during the intervals noted above appear in Tables 21 and 22, 23 and 24, and 25 and 26, for flocks 21A, 21B, and 21C, respectively. A sociogram for each study period is presented in Figure 5. The social hierarchy exhibited by these groups of White Leghorn cocks is based on peck-right dominance. The structure of the hierarchy deviates from the straight-line peck-order by virtue of several complexities apparent in the sociograms referred to above.

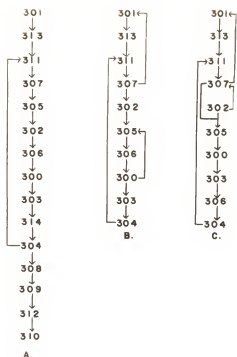


Fig. 5.--Sociograms of White Leghorn male flocks, 21A, 21B, and 21C.

TABLE 21
AGGRESSIVE INTERACTIONS IN FLOCK 21A:
NUMBER OF OBSERVED PECKS

Dominant Cocks	Subordinate Cocks																Total
	301	313	311	307	305	302	306	300	303	314	304	308	309	312	310		
301	..	8	10	13	7	14	6	21	13	10	8	6	14	17	10	157	
313	14	11	10	7	8	14	7	4	9	4	2	10	8	108	
311	3*	..	..	21	12	1*	3	4	5	10	3*	8	12	10	13	102
307	7	5	7	8	6	10	12	10	6	18	17	109	
305	6	4	10	17	6	10	7	4	4	3	71	
302	15	..	..	..	18	9	4	3	10	7	3	13	7	89	
306	8*	..	..	..	10	11	19	13	8	2	2	10	83	
300	..	2*	..	..	..	4*	..	..	31	21	2	14	8	10	13	105
303	8*	..	..	..	..	..	3	10	7	12	12	54	
314	17	..	..	..	..	2*	..	..	4	17	8	10	7	48	
304	9	9	21	6	62	
308	7*	..	..	..	..	8	7	3	25	
309	..	1*	..	..	..	2*	..	..	..	2*	..	..	..	5	4	14
312	8	8	
310	0	

*Peck-order violation.

TABLE 22
AGGRESSIVE INTERACTIONS IN FLOCK 21A:
NUMBER OF OBSERVED THREATS

Dominant Cocks	Subordinate Cocks															Total
	301	313	311	307	305	302	306	300	303	314	304	308	309	312	310	
301	..	18	31	10	11	13	22	8	10	18	14	22	11	18	13	219
313	21	17	8	8	9	13	18	11	17	24	17	19	18	200
311	16	11	1*	7	14	15	10	2*	16	11	13	17	133
307	7	12	14	10	17	17	11	21	18	24	21	172
305	..	6*	..	..	..	12	10	16	11	10	8	12	23	28	14	150
302	18	..	..	..	31	22	19	3	13	17	11	16	10	160
306	1*	..	..	12	14	7	32	12	14	17	10	119
300	8	16	10	18	17	23	106
303	..	8*	..	..	2*	..	..	..	..	12	4	10	10	21	24	91
314	3*	..	..	8	18	10	14	17	70
304	21	..	3*	..	..	..	..	..	..	4	3	7	10	48
308	1*	..	1*	..	..	..	..	6	2	8	18
309	5	10	15
312	2*	..	..	4*	..	..	..	2*	..	..	..	..	13	21
310	0

*Peck-order violation.

TABLE 23

AGGRESSIVE INTERACTIONS IN FLOCK 21B:
NUMBER OF OBSERVED PECKS

Dominant Cocks	Subordinate Cocks										Total
	301	313	311	307	302	305	306	300	303	304	
301	..	4	5	..	6	7	10	13	9	8	62
313	8	10	6	7	8	12	14	3	68
311	13	8	2	10	10	5	2*	50
307	8	..	..	..	6	9	3	8	10	7	51
302	4	6	11	10	2	33
305	..	2*	..	..	..	..	2	..	17	2	23
306	1*	..	..	..	11	5	7	24
300	..	3*	..	..	..	10	..	..	3	9	25
303	4	4
304	12	..	..	..	..	..	..	..	12

*Peck-order violation.

TABLE 24

AGGRESSIVE INTERACTIONS IN FLOCK 21B:
NUMBER OF OBSERVED THREATS

Dominant Cocks	Subordinate Cocks										Total
	301	313	311	307	302	305	306	300	303	304	
301	..	8	10	..	8	7	8	10	12	17	80
313	14	13	9	9	5	17	9	5	81
311	14	12	8	14	17	18	..	83
307	12	..	..	..	10	13	10	9	13	19	86
302	9	12	17	14	11	63
305	2*	..	..	10	..	8	13	33
306	14	11	5	30
300	2*	..	1*	..	..	17	..	..	17	12	49
303	13	13
304	15	..	..	..	1*	..	..	..	16

*Peck-order violation.

As indicated in the tabulations of aggressive interactions, a number of peck-order violations occurred during each of the three periods of study. Many of these were in the nature of incipient fights that produced no alterations

in social status. However, four unobserved reversals in dominance did take place, two being noted at the inception of study of flock 21B, and two after adequate records of flock 21C had been collected.

TABLE 25

AGGRESSIVE INTERACTIONS IN FLOCK 21C:
NUMBER OF OBSERVED PECKS

Dominant Cocks	Subordinate Cocks										Total
	301	313	311	307	302	305	300	303	306	304	
301	..	14	12	..	13	6	10	13	18	5	91
313	21	13	18	12	7	15	9	7	102
311	10	5	10	11	17	11	..	64
307	9	..	..	..	..	5	13	5	14	12	58
302	1*	12	..	8	17	10	16	8	72
305	9	11	7	13	40
300	..	1*	..	2*	..	..	..	10	5	9	27
303	6	4	10
306	..	1*	..	..	..	..	2*	..	..	7	10
304	12	..	3*	..	..	..	..	..	15

*Peck-order violation.

TABLE 26

AGGRESSIVE INTERACTIONS IN FLOCK 21C:
NUMBER OF OBSERVED THREATS

Dominant Cocks	Subordinate Cocks										Total
	301	313	311	307	302	305	300	303	306	304	
301	..	18	14	..	21	16	17	18	16	8	128
313	17	10	19	22	15	10	11	15	119
311	15	7	7	18	18	9	..	74
307	15	..	..	..	..	18	10	9	12	11	75
302	..	1*	..	21	..	4	15	6	13	9	69
305	17	14	8	6	45
300	..	1*	..	..	2*	..	..	15	14	12	44
303	10	14	24
306	8	8
304	18	..	..	2*	..	..	..	..	20

*Peck-order violation.

Throughout the entire study of this flock of White Leghorns, there was but a single instance of a dominant cock displaying the waltz to a subordinate. Growing during observation periods was also rare, affording little opportunity for the assessment of the role of social status in successful vocalization of this type.

Note that the number of threats observed is somewhat greater than that of pecks. The cocks were approximately three years old when first assembled and the less vigorous aggressive display may be a corollary of maturity.

In general we see no marked distinctions between the hierarchal behavior of the Red Jungle Fowl males and that of this small sample of White Leghorn cocks. Both forms show some flexibility with respect to dominance-subordinance relationships, and peck-order violations occurred in both. No special emphasis is placed on the larger numbers of these latter phenomena recorded for Jungle Fowl cocks. A report by Masure and Allee (1934) on social order in a flock of eleven Brown Leghorn cockerels presents a picture similar to that provided above, and further substantiates the conviction that no essential difference in hierarchal behavior exists between common domestic and Jungle Fowl males.

SOCIAL ORGANIZATION IN HETEROSEXUAL FLOCKS OF RED JUNGLE FOWL

In considering observations on heterosexual flocks attention is first given to those data that concern hierarchal behavior. A subsequent section deals with reproductive behavior and includes the presentation of observations that interrelate these two facets of behavior.

Flock 18

Hierarchal behavior in its simplest form is demonstrated in this group consisting of four males and three females. These individuals were five and one-half months old when study of the flock was begun on November 14, 1952. Observations were continued until March 24, 1953, for a total of 16.5 hours spread over a 66-day period. A tabulation of pecks and threats recorded during this period appears in Tables 27 and 28, respectively. Sociograms illustrating the structures of the social organizations so determined are presented in Figure 6.

Two features are immediately apparent from these data. Within this small group, two distinct hierarchies are discernible, each including individuals of one sex. The structure of each hierarchy is of the simple, linear type. We note further that although the tendency is for individuals to peck only members of their own sex, some instances of the pecking of birds of the opposite sex were recorded.

COCKS

30
↓
33
↓
31
↓
32

HENS

50
↓
52
↓
51

Fig. 6.--Sociograms of Heterosexual Flock 18

TABLE 27

AGGRESSIVE INTERACTIONS IN FLOCK 18:
NUMBER OF OBSERVED PECKS

Dominant Cocks	Subordinate Cocks				Subordinate Hens			
	30	33	31	32	50	52	51	Total
30	..	17	34	21	..	3	..	75
33	..	..	33	18	..	..	2	53
31	..	2*	..	19	..	..	..	21
32	1*	4*	2*	..	1	2	5	15
Dominant Hens								
50	..	3	..	..	..	18	14	35
52	1	..	..	..	2*	..	15	18
51	..	..	..	..	..	..	..	0

*Peck-order violation.

TABLE 28

AGGRESSIVE INTERACTIONS IN FLOCK 18:
NUMBER OF OBSERVED THREATS

Dominant Cocks	Subordinate Cocks				Subordinate Hens			Total
	30	33	31	32	50	52	51	
30	..	12	19	22	..	..	..	53
33	8	11	..	..	..	19
31	7	..	..	..	7
32	0
Dominant Hens								
50	11	8	19
52	5	5
51	0

A subjective judgment must at times be made when males peck females, with respect to whether such activity is of a hierarchal or social nature, or of a sexual or mating nature. Distinguishing criteria to aid the observer in making this distinction are tenuous. For the present those pecks directed by male members of the flock to females are considered as

hierarchal in nature; this matter is discussed further at a later time. On the other hand, instances in which hens pecked cockerels are considered as expressions of aggressive behavior. Such cases are small in number, and of unknown significance.

A further item of interest is the fact that aggressive interactions, pecks and threats, were more frequent between males than between females. Some peck-order violations were witnessed in both hierarchies. Despite these anomolous interactions, no reversals in dominance were noted, except as indicated below.

The following series of events are presented because of their interesting consequences. On the evening of March 18, two pairs of birds were removed: 30 and 32, alpha and omega males, respectively, and 50 and 52, alpha and beta hens. These birds were placed in exhibition cages and were reintroduced into the pen on March 22. The birds had been absent for a period of approximately 48 hours. On reintroduction, 33, beta cock, challenged 30. The resulting fight lasted thirty minutes, at which time 33 had successfully gained a reversal over 30. The latter was badly beaten, but 33 persisted in raining pecks on the former alpha cock. During the course of this fight, 31 occasionally entered to peck 30, and it was clear that 31 was now also dominant to 30. Six hours later when the flock was again observed, the new alpha cock, 33, was still pursuing 30 about the pen. The following morning, 30 was discovered dead on the floor, hackle feathers

missing, comb and wattles mutilated. Neither the omega male, 32, nor the reintroduced hens were involved in these disturbances. This was the first of a series of observations in which reintroduced birds became disassimilated. At this point, study of the flock was discontinued.

Flock 25

Study of the hierarchal behavior of this group began on January 19 and extended to June 9, 1953, for a total of 16.6 hours of close watching distributed over 67 days. Tabulations of pecks and threats appear in Tables 29 and 30, respectively, and the social hierarchies so found are depicted in sociograms presented in Figure 7. The birds comprising this flock were mature adults when assembled. As indicated in the tabulations and sociograms, two separate social organizations are present, each organized into straight-line dominance hierarchies. Some peck-order violations between males were recorded; none were observed among the hens. One reversal in dominance took place between males 164 and 154, following an extremely hard-fought contest that was initiated by 154. The triggering circumstances for this, and other apparently spontaneous reversals are not obvious to the observer. Prior to this particular reversal, there were no discernible indications of approaching exchange of dominance.

We note again the occurrence of pecks directed by cocks to hens. The behavior of both individuals in these

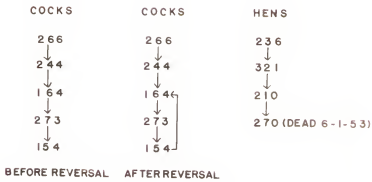


Fig. 7.--Sociograms of Heterosexual Flock 25

social interactions differed in no detectable manner from that which occurs when one cock expresses his dominance over a subordinate male. That is, there was no evidence indicative of the preliminary approaches employed by cocks in mating attempts.

One aspect of the hierarchal behavior manifested in this group was the infrequent observation of aggressive interaction between the hens. This tendency was most prominent during the final month of study, when two consecutive hours of observation revealed no aggressive-submissive behavior. The hens were not in the best physical condition, and 270, omega hen, died of pullet disease June 1, 1953.

TABLE 29

AGGRESSIVE INTERACTIONS IN FLOCK 25:
NUMBER OF OBSERVED PECKS^a

Dominant Cocks	Subordinate Cocks					Subordinate Hens				Total
	266	244	164	273	154	236	321	210	270	
266	..	28	18	15	19	3	7	4	3	97
244	..	..	31	12	18	..	8	..	..	69
164	..	..	..	29	14	..	5	4	2	52
273	..	4*	5*	..	10	..	..	..	..	19
154	2*	..	<u>18</u>	..	..	..	..	..	..	20
Dominant Hens										
	236	321	210	270		..	17	14	23	54
	321	..	..	..	..	..	..	18	4	22
	210	..	..	..	..	..	..	..	8	8
	270	..	..	..	..	..	..	..	..	0

^aUnderlining indicates reversals.

*Peck-order violation.

TABLE 30

AGGRESSIVE INTERACTIONS IN FLOCK 25:
NUMBER OF OBSERVED THREATS*

Dominant Cocks	Subordinate Cocks					Subordinate Hens				Total
	266	244	164	273	154	236	321	210	270	
266	..	38	43	19	17	..	..	..	..	117
244	28	34	24	..	..	..	..	86
164	19	18	..	..	..	..	37
273	9	..	..	..	..	9
154	<u>29</u>	..	..	..	..	..	..	29
Dominant Hens										
236	12	8	14	34
321	9	10	19
210	5	5
270	0

*Underlining indicates reversals.

Flock 23C

This heterosexual flock was assembled on December 16, 1953, and was studied until May 18, 1954, for a total of 25 hours of close observation distributed over 101 days. Originally composed of six cocks and six hens, the number of males was reduced during the final three months by the deaths of 244 and 154 of pullet disease.

The social organizations determined for this group are illustrated in Figure 8. These hierarchies are based on aggressive interactions that are tabulated and presented in Tables 31 and 32 for pecks and threats, respectively. The two social organizations are of the straight-line type with no triangular dominance relationships. This group is marked by the small number of peck-order violations observed between

COCKS

94
↓
24
↓
244 (DEAD 3-7-54)
↓
154 (DEAD 4-1-54)
↓
273
↓
83

HENS

18
↓
20
↓
236
↓
65
↓
154
↓
28

Fig. 8.--Sociograms of Heterosexual Flock 23C

males. No instances of reversals in dominance were noted. The characteristic stability of the hierarchy among Jungle Fowl hens is well documented by this flock. The highly-aggressive alpha hen, 18, continued her despotic behavior first seen when flock 23A was under observation, and frequently and persistently pursued subordinate flockmates.

TABLE 31

AGGRESSIVE INTERACTIONS IN FLOCK 23C:
NUMBER OF OBSERVED PECKS

Dominant Cocks	Subordinate Cocks						Subordinate Hens						Total
	94	24	244	154	273	83	18	20	236	65	154	28	
94	..	42	51	39	47	32	4	..	3	10	..	9	237
24	62	31	29	17	..	..	..	..	3	4	146
244	22	18	5	43	29	17	28	11	19	192
154	..	3*	..	..	8	2	1	2	1	..	..	..	17
273	4*	..	10	..	..	..	..	..	..	14
83	2	1	..	3
Dominant Hens													
18	11*	..	..	..	..	27	19	32	25	14	128
20	31	15	19	21	86
236	18	4	13	35
65	7	2	9
154	3	3
28	0

*Peck-order violation.

The aggressive behavior directed by male 244 to hens merits consideration. This cock repeatedly exercised peck-right over all hens. There was no indication that these pecks or threats, indicated in Tables 31 and 32, were of a mating nature. It was thought that the behavior of 244 might have some basis in an endocrine abnormality; he was smaller

than like-aged cocks and had incompletely developed plumage and comb. However, a post-mortem examination revealed that the gross anatomy of the gonads was normal, and as noted above, 244 died of chronic pullet disease.

TABLE 32

AGGRESSIVE INTERACTIONS IN FLOCK 23C:
NUMBER OF OBSERVED THREATS

Dominant Cocks	Subordinate Cocks						Subordinate Hens						Total
	94	24	244	154	273	83	18	20	236	65	154	28	
94	..	34	28	15	19	12	..	7	..	3	..	..	118
24	42	21	13	2	..	1	..	2	..	..	81
244	7*	..	..	17	14	9	10	3	..	4	..	8	72
154	3*	..	..	..	7	12	..	..	..	..	..	..	22
273	10	..	..	..	..	..	..	10
83	1*	..	..	..	..	..	..	..	..	1
Dominant Hens													
18	19	9	22	14	12	76
20	10	18	5	7	40
236	14	22	15	51
65	2	12	14
154	9	9
28	0

*Peck-order violation.

The aggressive attacks by 244 against females in the flock brought retaliation by 18. On one occasion, 18 and 244 assumed fighting postures and began to spar. This development was terminated by the interference of hen 65 who while passing between the posturing birds was vigorously pecked by both. Subsequently, 18 and 244 resumed feeding.

Reference to the tabulations of pecks and threats reveals a larger number of these expressions of aggressive

behavior exhibited by cocks. Of the total 870 observed pecks, 609, or 70 per cent, were delivered by cocks and only 261, or 30 per cent, by hens. Some of this differential may be attributed to the behavior of 244, but the fact that during the final three months of study only four males were present, emphasizes what is thought to be a real difference in hierarchal behavior between the sexes in heterosexual flocks. A similar situation exists when the number of recorded threats is examined. In this instance, the differential is 61.5 per cent for males as opposed to 38.5 per cent for females.

With the exceptions noted above, this heterosexual flock presents a typical picture of two separate hierarchies. Males other than 244 were rarely observed in aggressive interactions with hens; only 18 among the latter was noted in aggressive interactions with a male.

Flock 24C

The presentation of data gathered on the hierarchal behavior of heterosexual flocks closes with a discussion of the present group. Flock 24C, composed of five cocks and six hens, was studied from December 4, 1953, to May 20, 1954, for a total of 24 hours distributed over 96 days. Tabulations of observed pecks and threats appear in Tables 33 and 34, respectively; sociograms based on these data are illustrated in Figure 9.

An outstanding feature of the organizational activity displayed by this flock was the instability of dominance-

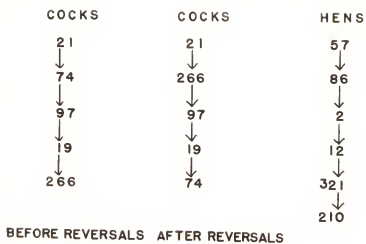


Fig. 9.--Sociograms of Heterosexual Flock 24C

subordination relationships that existed among the cocks. This instability was documented by the occurrence of five reversals in dominance.

TABLE 33

AGGRESSIVE INTERACTIONS IN FLOCK 24C:
NUMBER OF OBSERVED PECKS^a

Dominant Cocks	Subordinate Cocks					Subordinate Hens							
	21	266	97	19	74	57	86	2	12	321	210	Total	
21	..	39	28	10	<u>43</u>	..	..	..	3	..	..	123
266	<u>18</u>	24	17	..	1	..	2	..	2	64	
97	..	8	..	<u>17</u>	<u>21</u>	..	..	3	..	..	..	49
19	..	14	..	..	<u>19</u>	3	2	8	1	4	5	56
74	3*	9	11	12	..	1	..	..	2	..	..	38
Dominant Hens													
57	21	12	23	14	8	78	
86	32	19	7	10	68	
2	5	12	9	26	
12	11	4	15	
321	7	7	
210	0	

^aUnderlining indicates reversals.

*Peck-order violation.

The first reversal occurred under conditions which deserve comment. Prior to the observation of this flock on January 27, it was noted that 74, the second-ranking cock, had escaped into the area adjoining the pens. No effort was made to recapture 74 at the time, but that evening he was caught and placed in a nest box outside the pen. The following day, 74 was reintroduced at the start of the observation period. Shortly after his release 74 was challenged by 97. The ensuing fight in which 74 lost peck-right to 97 and was

blinded in the left eye was unique in that during its progress all other flock members either flew to the roost or went out into the yard. Those perched on the roost vocalized throughout the course of the fight in a peculiar manner, and appeared to watch the contesting males.

TABLE 34

AGGRESSIVE INTERACTIONS IN FLOCK 24C;
NUMBER OF OBSERVED THREATS*

Dominant Cocks	Subordinate Cocks					Subordinate Hens						
	21	266	97	19	74	57	86	2	12	321	210	Total
21	..	28	33	37	19	..	..	..	..	..	..	117
266	<u>15</u>	28	<u>23</u>	..	..	..	..	..	..	66
97	..	3	..	<u>11</u>	<u>29</u>	..	..	..	..	..	..	43
19	..	10	..	..	<u>35</u>	..	..	..	..	..	..	46
74	..	12	4	21	..	..	..	..	..	..	..	37
Dominant Hens												
57	14	19	10	17	2	62
86	22	18	7	10	57
2	10	4	3	17
12	7	2	9
321	8	8
210	0

*Underlining indicates reversals.

The following day, January 29, 266 gained a reversal over the battle-scarred 97. This reversal was not witnessed. As indicated in Table 33, three more reversals occurred, the final one being recorded on March 3. Tension between the males appeared to diminish after that date; no further reversals were noted.

The hierarchal behavior of the hens in this group was characteristically stable. No reversals or peck-order

violations were observed. We note again that fewer aggressive interactions were witnessed between hens than between cocks. The ratio of pecks and threats recorded in each subgroup for cocks and hens, respectively, was approximately two to one.

In structure, both hierarchies were of the simple, straight-line type. Males were rarely observed in aggressive interactions with hens, and the reverse was never witnessed.

Male Mating Behavior

In addition to the display of hierarchal behavior, some reproductive behavior is observed in heterosexual flocks. Four distinct categories of male mating activity are clearly discernible. These will be characterized and their occurrence in the present flocks indicated.

The most frequent type of mating activity exhibited is the waltz in which the male circles the female with his inner wing lowered, his body inclined toward the female, and his outer wing rapidly fluttered. As noted previously, males in unisexual flocks also display the waltz to subordinates. There is no apparent distinction between a waltz directed by a dominant to a subordinate cock and one directed by a cock to a hen.

Dommm and Davis (1948) considered the waltz as a method of sex recognition in domestic fowl; that is, if the bird to which the waltz is directed assumed the sex crouch, the male recognized a mating partner, whereas if the second bird responded by assuming a fighting posture the male then recognized

another male and an opponent.

On rare occasions, the waltz is followed immediately by a peck or an attempt by the cock to grab the comb or the neck feathers of the hen. Because of the confluence of these two activities, they are included as a single pattern in the present analysis. Pecks delivered by cocks in this context are considered as a part of mating behavior, in contrast to those which are not preceded by a waltz. The latter were presented in the preceding discussion as indications of dominance-subordination behavior, and in that context such pecks were not necessarily directed to neck feathers or comb.

A third category of mating behavior is designated mounting attempt. In such instances the male approaches from behind, hackle feathers erect, attempts to grasp the comb or the neck feathers of the hen in his beak, and simultaneously extends one foot to the saddle area of the hen's back. This procedure was never observed to be preceded by a waltz.

If the hen submits by assuming the sex crouch, copulation or treading follows. This final consummatory act is short-lived and is, in turn, followed by dismounting by the cock. The latter generally fluffs his plumage and crows, while the hen stands and fluffs.

With this descriptive material in mind, attention is directed to Table 35 which presents the mating behavior displayed by all males in the heterosexual flocks under discussion, plus the records of three cocks intermittently introduced

TABLE 35

OBSERVED MATING BEHAVIOR OF MALES
IN HETEROSEXUAL FLOCKS

Male	Flock	Rank	Number of Observed Waltzes	Number of Observed Waltzes and Grabs	Number of Observed Mounting Attempts	Number of Observed Copulations	Total Number of Displays	Number of Displays Per Hour
30	18	1	23	2	14	5	44	2.70
33	18	2	13	0	11	2	26	1.60
31	18	3	7	0	0	0	7	0.42
32	18	4	8	0	0	0	8	0.48
266	25	1	12	0	10	0	22	1.30
244	25	2	10	2	4	0	16	1.00
164	25	3(4) ^a	1	0	0	1	2	0.10
273	25	4	5	0	0	0	5	0.30
154	25	5(4) ^a	0	0	0	0	0	0.00
94	23C	1	45	3	21	7	76	3.00
24	23C	2	21	0	13	2	36	1.40
244	23C	3 ^b	3	0	10	0	13	0.72
154	23C	4 ^b	12	0	0	0	12	0.60
273	23C	5	8	0	0	0	8	0.30
83	23C	6	0	0	0	0	0	0.00
21	24C	1	38	4	43	8	93	3.90
266	24C	5(2) ^a	14	0	19	2	35	1.50
97	24C	3	9	0	0	3	12	0.50
19	24C	4	5	0	0	2	7	0.30
74	24C	2(5) ^a	0	0	0	0	0	0.00
106	10	1	27	10	49	15	101	10.10
62	10	2	11	0	0	2	13	1.30
23	10	3	0	0	0	0	0	0.00
Totals			272	21	194	49	536	

^aRank after reversals.^bDied during observation interval.

into flock 10. These latter individuals were admitted into flock 10 on every Friday evening between December 5, 1953, and March 21, 1954. They were allowed to remain in the pen until Sunday evening, at which time they were removed and placed in the unobserved surplus pen. While in flock 10, the dominance-subordinance positions of these cocks were noted, and their mating behavior closely observed for periods of 20 minutes on each Saturday and Sunday. The data tabulated for these individuals were collected during 10 hours of observation, distributed over 30 days.

Returning to an examination of Table 35, we note several factors that merit discussion. Of the four categories of behavior included, waltzing contributed the largest portion to the total, followed by mounting attempts, copulations, and waltz and grab instances, in that order. Only on two occasions was a waltz followed by copulation. The remaining 47 cases of copulation followed mounting attempts. The waltz and grab sequence was never observed as a successful preliminary to treading.

Heterosexual flocks were under close observation for 92.1 hours. During this time, a total of 536 instances of mating activity of all types were recorded, or an average of approximately six per hour. It is entirely possible that flocks undergoing observation did not display as much mating behavior as occurred in the absence of the observer. However, utilizing the available data it is our contention that low-

ranking males rarely succeeded in mating, at any time.

That there is an association between high rank and the display of mating behavior is indicated by the fact that the alpha and beta cocks in the various flocks contributed 462, or 86 per cent, of the combined total of 536 mating maneuvers. Contrariwise, the various omega cocks displayed mating behavior on only eight occasions.

A correlation coefficient (r) was calculated to determine the extent of association between social status and mating behavior. The total number of observed mating activities per hour for each cock was tested with the number of individuals each male was dominant over.

Table 36 presents a summary of this analysis. In all flocks r is extremely high, indicating a positive association between the two variables tested. The analysis was carried further with a test to determine the statistical probability of the calculated r . The null hypothesis is that r is equal to zero (Snedecor, 1945). Does the r of each flock differ to such a degree that the null hypothesis is rejected? In flocks 25, 24C, and 23C, composed of five, five, and six males, respectively, r is found to be significant at the 5, 5, and less than 1 per cent levels of confidence, respectively. However, the r values for neither flock 18 nor 10 passed the test for significance. In the former case, the probability of obtaining an r as high as + 0.94 is 5 to 10 out of 100 cases on the basis of chance alone. For flock 10, this probability is 20

to 30 out of 100 cases on a chance basis. In other words, these two values for r could have been the result of sampling error, with the few individuals involved.

TABLE 36

CORRELATION BETWEEN RANK AND DISPLAY
OF MATING BEHAVIOR IN MALES

Flock	N	Hours Observed	Mating Reactions Per Hour	Correlation Coefficient (r)	P
18	4	16.5	5.20	0.94	0.10 to 0.05
25	5	16.6	2.70	0.90	0.05
23C	6	25.0	6.02	0.93	<0.01
24C	5	24.0	6.20	0.90	0.05
10	3	10.0	11.40	0.93	0.30 to 0.20

However, the likelihood of obtaining five very high values for r in five consecutive trials seems remote, and despite the lack of statistical significance in two of the flocks, we are convinced of the validity of these findings. A scatter diagram for each flock, with a trend line calculated by the method of least squares appears in Figures 10 and 11.

These data suggested a simple experimental procedure that would serve to increase our confidence in the preceding observations. To this end, a male flock, sex-segregated for approximately six months and consisting of six cocks, was selected as a test group. The straight-line dominance hierarchy of the flock from alpha to omega was: 21, 97, 273, 287, 74, and 101.

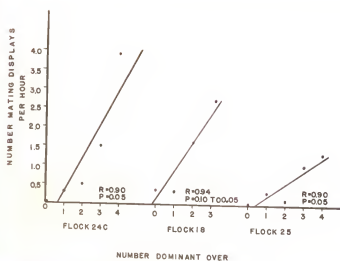


Fig. 10.--Scatter diagrams of male mating behavior in flocks 24C, 18, and 25.

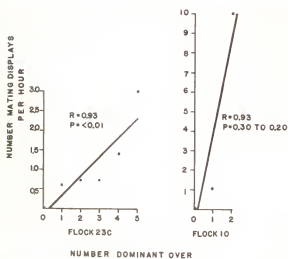


Fig. 11.--Scatter diagrams of male mating behavior in flocks 23C and 10.

The procedure was as follows. A hen from a female flock was removed from its pen the evening preceding the test, and placed in a trap nest. Prior to beginning the test the following morning, all cocks were lured out of the pen by placing grains in a central area of the yard. The door to the pen was locked and the hen placed in the yard. Observations of mating behavior were collected for 20 minutes. In addition to the four categories of male mating behavior described in the preceding section, a fifth pattern consisting of pursuit of the hen by a male appeared under these test conditions.

Observations were recorded during three test periods, with an interval of one week between each test. These data are presented in Table 37. Seventy-five of the 81 instances of mating displays of all categories, or 92 per cent, were contributed by 21, the alpha cock.

TABLE 37

TEST OF MALE MATING BEHAVIOR: NUMBER OF MATING
DISPLAYS WHEN ALL COCKS ARE PRESENT

Cock	Number of Mating Displays		
	First Trial	Second Trial	Third Trial
21	19	32	24
97	0	0	0
273	0	0	0
287	5	0	0
74	0	0	0
101	1	0	0

A fourth test was run in which 21 was locked inside the pen for ten minutes after the hen had been released. Tallies of the mating displays of the five remaining cocks

were made during this ten-minute interval, after which 21 was released. Observation of the now complete flock was continued for another ten-minute period. The resulting tallies appear in Table 38. Twenty-six instances of mating behavior were recorded prior to the release of 21. All but two of these were executed by 97, the beta cock. After his release, 21 contributed all of the 20 instances of mating activity recorded during the final ten-minute phase of the test.

TABLE 38

TEST OF MALE MATING BEHAVIOR: NUMBER OF MATING
DISPLAYS IN THE ABSENCE AND PRESENCE OF 21

Cock	Number of Mating Displays	
	First Ten Minutes	Final Ten Minutes
21	Absent	20
97	24	0
273	0	0
287	1	0
74	1	0
101	0	0

A fifth trial carried the experiment one step further with the exclusion of both 21 and 97 from the yard at the outset of the test. Ten minutes after observation of the flock commenced, 97 was released. Following a further interval of ten minutes, 21 was released. Table 39 presents these data, and we note that during the first ten-minute phase, twelve of the thirteen mating displays were committed by 273, gamma cock; during the second ten-minute phase the hen was monopolized by 97, beta cock. Mating activity during the final ten-minute

phase was dominated by 21.

TABLE 39

TEST OF MALE MATING BEHAVIOR: NUMBER OF MATING DISPLAYS
IN THE ABSENCE AND PRESENCE OF 21 AND 97

Cock	Number of Mating Displays		
	First Ten Minutes	Second Ten Minutes	Final Ten Minutes
21	Absent	Absent	18
97	Absent	19	0
273	12	0	0
287	1	0	0
74	0	0	0
101	0	0	0

A final test was made after the hierarchy of the flock had been experimentally readjusted. The alpha cock, 21, was removed and placed in isolation for five days. When reintroduced, 21 was engaged by 97 in a hard-fought contest that resulted in the reversal of 97 over 21. The remaining members of the flock except 101 also engaged 21, while the group was under observation. Subsequent study indicated that 21 had lost status to 97, 273, 287, and 74.

Two days following these reversals, a final test was run, the results of which appear in Table 40. All cocks were present in the yard when the hen was released. Twenty-five instances of mating behavior were witnessed, all but two executed by 97, the new alpha cock. The former top-ranking male, 21, did not display mating behavior, and, indeed, kept completely out of the area of activity.

TABLE 40

TEST OF MALE MATING BEHAVIOR AFTER
DEPOSITION OF 21

Cock	Number of Mating Displays
97	23
273	2
287	0
74	0
21	0
101	0

There can be no doubt that under the conditions of these tests, there is a marked tendency for high-ranking and very little tendency for low-ranking males to display mating behavior.

Female Mating Behavior

Among hens in heterosexual flocks of Red Jungle Fowl the exhibition of mating behavior is less varied than among cocks. In general, females show three types of response to mating advances by males. The most frequent response is one of avoidance. This ranges from moving a step or two away from the male, to rapid evasion. A second response is acceptance and copulation. The final type of reaction is an apparent complete disregard of the male.

It is of interest to recast the data presented in the preceding section to determine if a relationship exists between rank in the female hierarchy and the number of mating displays directed to a given hen. These data are presented in the form of scatter diagrams in Figures 12 and 13.

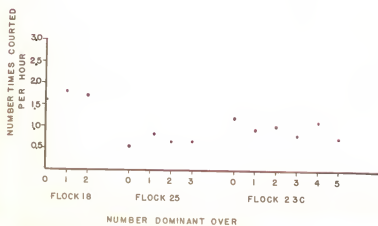


Fig. 12.--Scatter diagrams of female mating behavior in flocks 18, 25, and 23C.

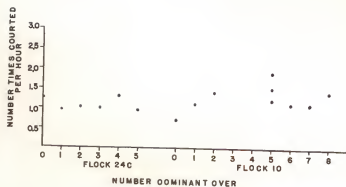


Fig. 13.--Scatter diagrams of female mating behavior in flocks 24C and 10.

There is no discernible association between rank or number of individuals dominated and the number of mating displays directed to a given hen. Low-ranking hens are as apt to receive mating advances as are high-ranking hens.

It is pertinent to note again the small number of mating reactions recorded with respect to the total amount of time during which this behavior was observed. That a substantial amount of reproductive activity occurred unwitnessed is pointed up by the appearance of a patch of skin denuded of feathers behind the comb of all hens. This area was particularly visible from early to late spring, and was the result of mating activity by males.

Although eggs were laid throughout the year, the most successful period for reproduction in this colony was from February to July. A clutch of five to eight eggs was deposited on the pen floors or in the yards. When eggs were laid in the pen, incubation proceeded with difficulty only in those cases in which two hens were in production at the same time. There was a tendency for the dominant hen of such a pair to gather as many of the eggs as possible under her. This procedure resulted in the somewhat ludicrous circumstance of two brooding hens, huddled wing to wing, with all the eggs under one.

After hatching, mortality of chicks developing from eggs laid in the pens was high. Although extremely protective, brooding hens were not able to prevent flockmates, male or female, from killing and eating the newly-hatched chicks.

For this reason, chicks hatched in the pens were removed and brooded artificially.

Those eggs laid in the yards fared somewhat better. However, chicks hatched from these eggs rarely lived to adulthood. They were subject to pecking by all adults except the broody hen when they entered the pen for feed.

Summary of Social Organization and Mating Behavior in Heterosexual Flocks

Heterosexual flocks of the Red Jungle Fowl exhibit two distinct hierarchies, each including individuals of one sex. With the exception of cock 244, males rarely reacted to females in an aggressive manner. In some instances, it is difficult to determine whether a peck by a cock is an incomplete mating attempt or a reflection of aggressive behavior. Hens peck males infrequently, but our data are of insufficient quantity to elaborate on this phenomenon.

Structurally, each organization varies, as it does in unisexual flocks. The hen organizations are quite stable with few peck-order violations and no reversals; cock hierarchies show instability in the form of peck-order violations and reversals. In all flocks, the number of observed aggressive interactions tends to be greater between cocks than between hens. The causal factors involved in this differential are not clear. Males were never observed to interfere actively in aggressive interactions between hens.

The study of heterosexual flocks included the recording of mating behavior. Although only 49 cases of copulation were witnessed, the occurrence of other manifestations of mating allowed an opportunity for an analysis that revealed the following information. There is a high degree of association between social status in the male hierarchy and the exhibition of mating displays. Correlation coefficients calculated on the basis of number of mating displays of all kinds and number of cocks dominated, indicate a high correlation in all flocks. However, in two flocks, because of the small number of cocks, the coefficients were found to be insignificant, and could very well have been due to sampling error.

A series of tests using a sex-segregated cock flock reinforced our conviction that males of high status are more active sexually.

Among hens, there is no apparent association between status and the number of times a given individual is courted. This held true even in those instances in which copulation followed courting.

The rearing of chicks hatched in the pens and yards was not successful. In order to maintain the colony, it was necessary to remove newly-hatched chicks and brood them artificially, since chicks left in the pens were generally pecked and killed by the adult residents.

STAGED INITIAL ENCOUNTERS BETWEEN HENS

A series of pair-contests was conducted between hens that had no previous experience with each other. This procedure simulates the conditions that are present in assembling a flock when a number of individuals are placed together for the first time. However, the pair-contest situation is very much simplified in that only two hens are present in a pen unfamiliar to both. Approximately thirty contests were conducted, but the disrupting effects on the general behavior of the hens as a result of handling in daylight forced a discontinuation of the project.

In view of the small number of experiments it is felt that a detailed analysis of the results would not be rewarding. Some impressions will be presented, with the understanding that they are not based on extensive data.

When placed together in an unfamiliar pen, two hens engage in a contest for dominance. During these initial encounters, one of the following conditions may pertain: (1) peck-right is actively established by fighting initiated by one or both individuals simultaneously; (2) peck-right is passively assumed by the avoidance of one hen by the other without an exchange of pecks or in the complete absence of physical contact; (3) no decision is reached during the period of time arbitrarily chosen for each contest.

When juvenile hens of four to six months were paired with adults, they invariably lost peck-right to the older hen. The most vigorous aggressive display by a hen was the waltz-and-grab sequence, previously described as a manifestation of male mating behavior. Postural differences were noted, but a complete series of postures as observed by Foreman and Allee (1954) for domestic hens in pair-contest experiments was not witnessed.

These preliminary observations indicate that an extensive series of pair-contests would be a worthwhile project not only with respect to Red Jungle Fowl hen behavior, but from a comparative point of view. There is presently available a considerable amount of data pertaining to pair-contests in the common domestic hen.

Because of the pugnacity of males, pair-contest experiments are not recommended. A few were conducted in the present study, but it was clear that too often cocks will fight until one is dead.

TERRITORIALITY

As defined by Allee et al, (1949), "Territoriality includes homing or the defense of a given area, or both." Nice (1941) has characterized a number of different types of territoriality exhibited by various species of birds. An attempt was made to determine whether any phenomena which could be designated as territorial behavior exist in our subspecies of Red Jungle Fowl.

We have noted that displays of mating behavior in heterosexual flocks are most frequent during the spring. In addition, no indications of pair-formation were obtained in these flocks. It was thought that the restricted areas in which the flocks were maintained, combined with the relatively large number of individuals in each flock might serve to eliminate pair-formation.

A large yard, measuring roughly 50 x 22 feet, was used in four tests to determine the presence or absence of pair-formation and territorial defense of portions of the yard. Three nesting sites consisting of wooden boxes located about 20 feet apart were placed in the yard; each site was provided with a water container. A rank growth of weeds prevented visual contact at the level of the Jungle Fowl's head between the three nesting sites, and a centrally-located blind for the observer afforded a clear view of all three nests. All tests

were conducted during the spring months of 1953 and 1954.

Test 1

Three pairs of adults, selected from unisexual flocks, were released in the yard on April 5, 1953. The group was observed for periods of twenty minutes daily until May 10. Prior to the start of observation periods, grains were placed in front of each nest box.

The most frequent type of behavior exhibited was hierarchical in nature. Mating displays differed in no respect from that observed in the previously described heterosexual flocks.

On April 14, the beta cock executed a reversal over the alpha male. From that time until study of the group ended, the deposed male was observed with the others only at night. All birds roosted together on top of one of the nest boxes.

On April 14, the alpha hen became broody, laying eight eggs in as many days. Shortly thereafter, the two remaining hens likewise produced clutches of eggs. These were deposited in shallow depressions on the ground, and were well hidden by grasses. After hatching, the chicks were protected by their respective dams, and cocks were not seen in close proximity to any of the brooding hens. Each hen kept apart from the other females, and based on size differences of the chicks from each clutch, no mixing of offspring occurred.

Test 2

On March 29, 1954, two pairs of seven-month-old birds

were placed in wire cages each located at opposite ends of the yard. The nest boxes used in the preceding test were removed. The birds were caged for three weeks, feed and water being supplied daily.

On April 18, at 5 a.m., the cages were opened and observations taken. Two and one-half hours after release, both pairs had moved out of their respective cages and wandered about the yard. During this interval of moving, the cocks crowed continuously. In these random movements, the hens did not accompany cocks with which they had been caged.

Four hours after release, dominance relations between birds of each sex became established; a short fight occurred between the cocks, whereas peck-right was settled by the avoidance of one hen by the other.

The following morning, after grains were placed in front of each cage, it was noted that a male from the pen adjoining the experimental yard had gained entry. The test, so disrupted, was discontinued.

Test 3

Two different pairs of adults were used in the third test, one pair being caged at each end of the yard for three weeks. After being released at 5 a.m. on May 16, 1954, dominance relationships were promptly established. Four hours after release, both hens were observed to accompany the alpha cock about the yard. The beaten male stayed out of contact

with the others. Observations were continued for ten days during which time mating behavior between the alpha cock and both hens was witnessed. The omega male joined the others only at night when all roosted together.

Test 4

The final test followed the pattern of the preceding two. Two pairs of birds were caged for three weeks. Early in this interval, one hen laid a clutch of six eggs and began to incubate them. The cock with which she was kept soon showed evidence of brooding behavior, and five days after the eggs were laid cock and hen sat wing to wing with all the eggs under the former. This curious behavior was unique in that no other instances of a brooding male were encountered.

The cages were opened at 5 a.m. on July 18, 1954, after a three-week period, and throughout their first day of freedom both pairs remained within five feet of their respective cages. The day after release initial encounters occurred and dominance relations became established, with the formerly broody cock assuming alpha status. All birds moved about the yard together. Hierarchal and mating behavior were witnessed, but these phenomena were in no way distinct from those occurring in large heterosexual flocks. One week after release, the omega cock was found dead, apparently as the result of fighting with the alpha cock.

In summary, the release of pairs of Red Jungle Fowl into a large yard resulted in the exhibition of hierarchal and mating behavior similar to that witnessed in larger heterosexual flocks. Birds which had been caged for three weeks prior to release did not appear to maintain a territory about their respective cages. The highly aggressive behavior shown by alpha cocks resulted in the death of one omega male, and the exclusion of two different omega cocks from contact with other birds in the yard. The fact that all birds roosted together at night although during the daylight one cock might be excluded from association with his yardmates is further evidence for a lack of territorial behavior. No indications of pair-formation were noted in any of the tests.

DISCUSSION

Small flocks of Red Jungle Fowl hens clearly exhibit a social organization based on the peck-right type of dominance-subordination relationship between members of the group. Dominance is manifested by overt behavioral activity such as pecking and threatening. The structure of the social organizations found in the four flocks under discussion ranges from the simple, straight-line hierarchy in flock 23B to the rather complicated geometrical-type of organization of flock 10B.

The rigidity of dominance relationships among flock members is amply illustrated by the data presented above. A combined total of 9,279 pecks and threats were recorded during 78.3 hours of observation, extending from July 1953 to November 1954. Of this total, there were only fifteen instances in which an observed aggressive act ran counter to the known dominance-subordination relationships of the hens. The role of such peck-order violations in the dynamics of hierarchal behavior is incompletely understood (Holabird, 1955). These phenomena may indicate conditions of stress preliminary to actual reversal in dominance between members of the contact pair, but there is no evidence from the present study that such is the case. On the other hand, such behavior may simply reflect the rapid movements that are characteristic of the feeding hens.

Misdirected aggressive activity under these circumstances seems entirely likely; the rareness of such behavior is mute testimony of the ability of Jungle Fowl hens to recognize their flockmates precisely and rapidly, and to react appropriately in the vast majority of contacts.

The stability of dominance-subordinance relationships in this form is further indicated by the behavior of those hens which were members of two flocks. With one exception, such individuals maintained the same relationship to each other in both flocks.

The expression of submissive behavior by the subordinate of a pair-contact has not been emphasized. The response of subordinate individuals to pecking or threatening by socially dominant flockmates is such as to increase the distance between the dominant and the interacting subordinate. The latter may move her head away from the dominant, or may run or fly out of the feeding area. The form of the avoiding response was of particular interest only in those cases in which subordinate hens exhibited the sex crouch to an overt aggressive act by hen 18, alpha member of flocks 23A and 23B. Under these conditions, the sex crouch is an unadaptive response. A hen in this attitude may remain motionless while being pecked repeatedly by the dominant. The sex crouch so displayed may be an example of a displacement activity. As generally defined by Thorpe (1951) a displacement activity is, "The performance of a behaviour pattern out of the particular functional context of behaviour to which it is normally related."

The sex crouch may be considered as a typical response given by a sexually receptive hen when pecked by a cock approaching from behind. After the first sex crouch was noted in flock 23A, care was exercised to observe the manner of approach of hen 18 when interacting with subordinates. Recall that 18 was a particularly aggressive individual, and that she frequently chased subordinates for some time before returning to the feeding area. It is interesting to note that four of the five cases of sex crouch response to 18 occurred when the latter was in pursuit of the subordinate individual and was thus approaching vigorously from behind, as would a male attempting to mount. The small number of these observations, however, demands cautious interpretation. Pursuit by dominants did not invariably, or even frequently, evoke the sex crouch by the subordinate individual.

It would be of interest, at this point, to compare the hierarchal behavior of Red Jungle Fowl hens with that of common domestic hens. Beginning with the published works of Schjelderup-Ebbe (1913, 1922, 1935), and extending through the investigations of Allee and his students, a rather considerable body of information concerning social organization in common domestic fowl is available. The reviews of Allee (1950) and Guhl (1953) represent the latest summaries of this field, and the reader is directed to these papers for documentation of many of the comparative statements to follow.

There is no essential difference between the type of social organization exhibited by small flocks of the two forms. In both, the hierarchy is based on peck-right dominance. Social relationships between individuals are determined during initial pair-contacts and are of an enduring nature. The structure of the hierarchy varies from the simple straight-line type to the complex geometrical peck-order in which complicated dominance relationships are encountered.

The manner in which dominance is exercised is the same in both Red Jungle Fowl and common domestic hens. Pecking and threatening are the primary manifestations of dominance behavior. Fighting rarely occurs in organized flocks of domestic hens. It was never encountered in the present study. The activity of subordinate members of interacting pairs is similar, and varies from slight avoidance movements to rapid evasion of the dominant.

In a study designed to test the ability of domestic hens to become part-time members of a number of flocks, Douglass (1948) noted that dominance relations of test hens did not change when the hens were moved from one flock to another even though one member of the pair may have attained higher status in a given flock than did its transfer partner. This finding is paralleled, with the single exception noted previously, by the behavior of those hens that were members of two flocks in the present study.

In a general way, the social organization found in small, penned flocks of Red Jungle Fowl males is similar to that of hens. Dominance is of the peck-right type and the hierarchies range in complexity from the simple, straight-line type found in the male flock used for tests of mating behavior, to the highly complicated structures present in flock 3. However, hierarchal behavior of males differs from that of females in the relative lack of stability manifested in dominance-subordinance relationships. Peck-order violations are frequent in male flocks, and complete reversals in dominance relationships common.

Competition for high rank in the male hierarchy is extreme. Fights developing for reasons not apparent to the observer frequently result in permanent bodily injury or even in the death of a defeated cock.

The most striking example of the highly competitive nature of the male hierarchy is the history of 1, alpha cock of flock 3. When a member of this group, 1 was an aggressive despot, exercising peck-right over all subordinates in a persistently harassing manner. During the first two months of study, 1 was also alpha in the organization of flock 24A. Abruptly, 1 lost status in a series of reversals to all but the omega male. Following these reversals, 1 was virtually an outcast, being continuously driven about the pen and yard. Still later, when a member of flock 24B, 1 continued in a subordinate status, and finally succumbed to persistent attacks

by dominant members of the flock.

Dominance was demonstrated not only by pecking and by threatening behavior, but also by the tendency of dominant males to prevent crowing by subordinate cocks. It is difficult to conceive of crowing as an aggressive challenge in the conditions under which the male flocks were studied. At best, crowing by subordinates might be considered as an extremely cryptic challenge, particularly when a dominant was in close proximity. In such circumstances, the slightest threat by the dominant was usually a sufficient stimulus to curtail the vocalization.

Waltzing by dominants of subordinate individuals was noted in all flocks, but was most prominent in flock 3. Infrequently, attempts at homosexual mating were witnessed in all male groups except flock 3. In these instances, the cock attempting to mount was always higher in the social organization than the interacting male. Successful mounting was never observed, and subordinate males were never seen in the sex crouch position assumed by receptive hens.

The unique behavior observed in flock 3 has been discussed. The reasons for recurrent reversals and very frequent waltzing displays are not clear. More work is suggested on closely confined groups of cockerels.

Schjelderup-Ebbe (1922) characterized the hierarchal behavior of domestic cocks as similar to that of domestic hens, with an additional comment concerning the tendency for cocks

to show a wilder type of behavior. Masure and Allee (1934) studied the social organization in a flock of eleven Brown Leghorn cockerels. They found the hierarchy to be less stable than that exhibited by a similar group of pullets. Dominance relationships between two pairs of cockerels were unsettled after a period of 70 days, and five cases of reversals in dominance were noted. The hierarchy was constructed of a series of triangles of dominance. No mention is made of waltzing and crowing in this report.

Guhl (1953) states that the organization in unisexual flocks of domestic males is similar to that of hens, except that interactions between cocks are more intense and dominance relationships less stable.

These reports agree with the observations presented above on a flock of fifteen and later of ten White Leghorn roosters. Reversals in dominance as well as peck-order violations were encountered in this group. These indications of a less rigid form of dominance-subordination organization are similarly apparent in the hierarchies exhibited by Red Jungle Fowl cocks. We conclude that no essential difference exists in the exhibition of hierarchal behavior of males of the two forms under consideration.

The hierarchy in heterosexual flocks of Red Jungle Fowl consists of two separate, sex-limited organizations. The hierarchal behavior manifested by each sex-grouping is completely compatible with that found in the respective unisexual

flocks. That is, status among hens is rigidly maintained with few peck-order violations and no reversals, whereas among cocks both indications of instability are common.

For the most part, cocks exert dominance over hens in a covert manner. Some instances of overt aggressive behavior directed to hens by males are encountered. One cock (244), abnormal in appearance, frequently exercised peck-right over all hens in his flock. The degree to which this exceptional behavior was displayed stands in contrast to the general comportment of males, noted above. Cocks clearly have precedence in feeding; it is curious indeed that such precedence is generally unaccompanied by repeated displays of aggressive behavior.

Cases wherein hens exhibit aggressive behavior to cocks are also exceptional. Only 18, a highly aggressive hen, was observed pecking males to any degree. This female was also involved in incipient fighting maneuvers with 244, the cock referred to above.

One other aspect of the hierarchal behavior recorded in heterosexual flocks is the differential in aggressive activity. In every case, hens were observed in fewer interactions than males. The causal factors involved in this differential expression of aggressive behavior are unknown. It is clear, however, that hens are in some manner inhibited in the display of aggressiveness by the mere presence of males. Cocks were never seen to interfere actively in aggressive

interactions among hens.

The assemblage of heterosexual flocks allowed the collection of data concerning mating behavior. Male displays include waltzing, waltzing and grabbing, mounting attempts, and copulation. Female exhibition of mating behavior is confined to the sex crouch. Other responses of hens to displaying cocks are in the nature of avoidance reactions or apparent complete disregard of the male.

Plotting combined number of mating displays per hour against number of cocks dominated revealed a high degree of association between these two quantitative variates. Correlation coefficients for all flocks were very high, but in two cases the observations could have been the result of sampling error with the small numbers of males involved. Testing a unisexual flock of six cocks for frequency of mating displays to an introduced hen, reinforced the conclusion drawn from observational data collected on heterosexual flocks. High rank in the male hierarchy was closely associated with the frequency of mating displays.

When these data were recast, and the frequency with which a given hen was courted was plotted against number of hens dominated, no association was revealed. Low-ranking hens were courted and trod as frequently as their social dominants.

The information concerning hierarchal behavior in heterosexual flocks of the common domestic fowl indicate two

separate hierarchies. Passive dominance of males over females is the rule, with rare exceptions. Instances of hens pecking cocks have also been observed, but these too are exceptional cases.

Most reports dealing with heterosexual flocks of domestic fowl are concerned with the relationship between hierarchal and mating behavior. These papers have been reviewed recently by Allee (1950) and Guhl (1953). It will be pertinent here to summarize those findings bearing on a comparison of domestic with Red Jungle Fowl behavior.

With respect to male mating behavior, it has been established that, in heterosexual flocks, high-ranking cocks tread more frequently and tend to sire more offspring than low-ranking males. Dominant cocks also tend to interfere in the mating efforts of their social subordinates. However, when introduced singly in hen flocks, the sexual vigor of individual males in no way reflects their social status.

Among domestic hens, the reverse situation obtains. Low-ranking hens are courted more frequently than those of higher social status. The correlation between status in the hierarchy and frequency of copulation is also negative.

The observations of the present study indicate no differences in the relationship of mating display with social status between Red Jungle Fowl and domestic cocks. A very marked distinction appears on the female side, however. No

relationship between status and frequency of being courted is observed in Red Jungle Fowl hens, whereas a negative correlation between these two variables is found in domestic hens. The same distinction appears with respect to copulation in the two forms.

It may be that the small number of forty-nine witnessed copulations in the present study afford too small a sample for the detection of differential mating in hens. Consideration of the combined data of mating displays indicates the same trend, however, and we are faced with a considerable difference.

The act of copulation in both forms clearly involves a large factor of submissiveness on the part of the hen. The only objective criterion of apparent receptivity in hens is assumption of the sex crouch. We have noted that some Jungle Fowl hens will assume the sex crouch when pursued by a highly aggressive hen. This phenomenon is also known to occur in unisexual flocks of domestic hens.

There is no positive evidence that the males of a heterosexual flock are cognizant of the social status of a given hen. There is thus no a priori reason for suspecting that cocks will display mating behavior more frequently to low than to high-ranking hens. In the absence of pair-formation for breeding purposes, we might assume that a given male will display mating behavior in a nonselective manner. That low-ranking domestic hens copulate more frequently than their social dominants is understandable if the mating pattern is

largely based on submissiveness. The curious point is that domestic hens low in the hierarchy not only engage in copulation more frequently than dominant ones, but also that the former are courted more frequently.

This observational fact, to be logically interpreted, demands the assumption that a male is in some manner aware of the relative submissiveness of each hen in his flock.

In a long-established heterosexual flock, it is quite likely that, on the basis of experience, a cock may recognize a differential in aggressiveness among hens. That is, some hens will assume the sex crouch more frequently than others. There are also postural differences between aggressive and submissive hens (Foreman and Allee, 1954) that could provide the necessary cues to males. It follows that the male might court such hens more frequently than their more aggressive flockmates. If this should occur, the explanation for a differential in frequency of being courted is then the result of the ability of males to detect, on the basis of long experience, or on the basis of subtle postural cues, differences in submissiveness of hens. Submissive behavior in hens is normally associated with low rank in the hierarchy. We may conclude that cognizance of low-ranking hens, as such, by cocks is quite indirect but effective in domestic heterosexual flocks.

The findings in the present study with respect to Jungle Fowl hens do not parallel those of domestic hens. There

is no reason to suspect that Red Jungle Fowl cocks are less perceptive of submissiveness in hens than domestic cocks. If the preceding argument is cogent, we should expect a differential in frequency of being courted, associated with rank in the female hierarchy. It is conceivable that the distinction rests on an actual difference between domestic and Red Jungle cocks, such that, in the latter, courting without regard to relative submissiveness of hens is an indication of higher sexual vitality in this form. Further experimental investigation of this problem would be a worthy venture.

Delacour (1951) reports that Cochín-Chinese Red Jungle Fowl (3. g. gallus) have been kept in a park located in Clères, Normandy. Under these conditions the birds are said to behave in a manner indistinguishable from wild birds in Indo-China. During summer, autumn, and winter, these free-ranging Jungle Fowl lived in small, mixed flocks. However, each spring, ". . . each of the stronger cocks keeps a territory with three to five hens." The dimensions of these territories are not given.

We have noted that maintenance of a territory and pair-formation did not occur in our heterosexual flocks. In tests conducted in a yard approximately 50 x 22 feet in length and width, there were no obvious indications of defense of a portion of the yard, or of pair-formation.

A different interpretation may be placed on the results of these tests if the entire yard be considered. In

all except the second test, which was discontinued because of the intrusion of a nonexperimental male, there was evidence indicating that alpha cocks exerted control over the yard. That is, they moved about freely and were seen displaying and mating with the hens. In test 3, the subordinate male was never observed with the two hens and alpha cock during the day. Test 4 gave the same indications, with fighting between males so extreme that the omega cock was killed. Test 1 was less conclusive because of the onset of egg production and broodiness in the hens. The winning of alpha status by the originally second-ranking cock was accompanied by the withdrawal of the former alpha male from the others. The omega cock of test 1 was seen in contact with hens and with the alpha male, although he was never observed in mating attempts.

Had low-ranking males been able to escape from the yard, the alpha cocks might then have been in the same position as the "stronger" cocks mentioned by Delacour.

The most obvious fault in this interpretation is the fact that all birds roosted together at night. Delacour makes no statements about roosting behavior but it seems safe to assume that a second cock would not be found roosting with the territory-holding male and his harem.

Repetition of these experiments using a larger area would test this interpretation, and pending such an investigation we feel that no generalizations should be drawn from the present study on territoriality.

There are approximately 45 standard breeds of domestic fowl (Am. Poultry Assoc., 1953). Each breed may, in turn, be divided into a number of varieties. The varieties are frequently further divided into strains. It is obvious that domestic fowl have undergone intense selection by poultry breeders for centuries. Among the many factors which have been under selection are color patterns, feather form, body size and conformation, meat and egg production, and broodiness. It is therefore of interest that in those breeds, varieties, and strains which have been studied, no basic differences in the manifestation of hierarchal behavior have been found. There are variations between breeds and between strains of a single breed variety with respect to levels of aggressiveness and other minor characteristics (Potter, 1949; Holabird, 1955), but it is noteworthy that despite long and intense artificial selection for other factors, few important differences in the expression of hierarchal behavior are known among flocks of G. gallus.

In concluding this part of the discussion it may be said that no basic distinction is found between the social organization of flocks of Red Jungle Fowl and of the common domestic fowl. Indeed, insofar as its hierarchal behavior is concerned, the Red Jungle Fowl does not differ from the common domestic fowl to any greater degree than certain breeds of domestic fowl are known to differ from each other.

The fact that social organization in the Red Jungle Fowl is basically indistinguishable from that of the closely-related domestic fowl is an indication of the fundamental nature of this behavioral phenomenon. Collias and Taber (1951) noted a social hierarchy based on peck-right dominance in free-ranging ring-necked pheasant hens (Phasianus colchicus) another species of the family Phasianidae in which both Red Jungle Fowl and domestic fowl are classified.

Such a widespread and persistent behavioral characteristic as social hierarchy is not without evolutionary significance. An evaluation of this problem differs on the individual and the group levels and a discussion of each is pertinent.

Competition within a flock for high social rank is extreme. We have seen that manifestations of aggressive behavior are more vigorous among males than among females and that the resulting organizations are more stable in the latter than in the former. This distinction may simply reflect the larger size of males and presumably larger titres of male hormone in the blood. The effectiveness of exogenous male hormone in increasing aggressiveness in domestic hens is well known (Allee, Collias, and Lutherman, 1939; Allee and Foreman, 1955).

The experimentally-demonstrated perquisites of high rank in flocks of domestic fowl are also well known. Among cocks, high social status is associated with greater realization of reproductive potential, as well as greater access to feed, water, and other essentials of individual survival.

Should such a system occur in nature, selection might favor the most aggressive males. This is certainly the case among males of free-ranging sage grouse (Centrocercus urophasianus), as reported by J. W. Scott (1941, 1942).

The situation among hens is less clear, for we have seen that, in domestic fowl, females of high rank may not fully realize their reproductive capabilities. There is no doubt that high-ranking individuals in both domestic and Red Jungle Fowl flocks are in an advantageous position with respect to individual maintenance.

The disoperative consequences of interindividual competition are obvious. If selection were to favor extreme aggressiveness in both male and female, a point of diminishing return would eventually be reached because the reproductive act, as such, requires a certain degree of submission by the hen. The complex of motor activities which we have designated as aggressive behavior is presumably genetically determined, although aspects of learning are certainly involved in its operation. It may well be that the tendency for low-ranking domestic hens to be more active in reproduction results in a balancing mechanism that serves to prevent a genetic overemphasis of those factors which make for aggressiveness.

A more basic consideration is presented when attention is shifted to the group as the unit of selection. Here the important question is whether flocks in which the social hierarchy is well-established are in an advantageous state relative

to unorganized groups. There is a paucity of experimental evidence on this basic question. Some insight is provided by the report of Guhl and Allee (1944) in which such factors as egg production, weight maintenance, and levels of aggressive activity of White Leghorn hens were studied. The hens were members of two subsamples of a single population, one of which consisted of organized, control flocks, and the other of flocks undergoing constant reorganization. They found the following relationships: hens in flocks undergoing reorganization showed a higher frequency of aggressive activity, consumed less feed, and tended to produce fewer eggs than those in control flocks. The conclusion of this study was that social organization, ". . . may serve to build a co-operative social unit better fitted to compete or co-operate with other flocks at the group level than are socially unorganized groups." It is our contention that a similar experiment using the Red Jungle Fowl would show the same trend if the tests were made during the spring period of highest egg production.

A practical application of the basic information disclosed by investigations dealing with social behavior in the domestic fowl has been the recent advent of caged-layer operations in the poultry industry. Within the past four years approximately one million individual cages for laying hens have been installed in Florida alone, representing a total investment of over three million dollars. One of the primary

reasons for this type of management is that birds in individual cages are not subject to the disoperative effects of the social hierarchy. Each individual has equal access to food and water with a resulting high level of egg production. The elimination of interindividual competition leads to a more complete realization of genetic potentialities for egg production as well as more efficient utilization of feed.

It should be emphasized that this study was conducted under conditions which were somewhat restrictive to the birds. It would be of interest to know the nature of the hierarchal behavior shown by Red Jungle Fowl in their natural environment. Descriptions of the natural history of the Red Jungle Fowl, such as that of Beebe (1926) and Delacour (1951) are not helpful in this respect. However, a recent report by Tordoff (1954) on the social organization of the red crossbill provides some insight into the present problem. A flock of this passerine species was observed in the field and its hierarchal behavior was noted. After trapping, the flock was observed under restricted conditions, and it was concluded that the only noticeable change was an increase in display of aggressive-submissive activity.

Social organization is a factor exerting a dynamic influence on the total biology of certain grouped animals. An appreciation of the significance of these intricate and subtle interrelationships can prove a potent instrument for a more complete understanding of group biology.

SUMMARY

1. The social organization of twenty-six Red Jungle Fowl hens comprising four flocks was studied for a combined total of 78.3 hours extending from July 7, 1953, to November 23, 1954.
2. A social hierarchy based on peck-right dominance relationships was found in each flock; only one case of reversal of dominance was encountered.
3. Other evidence of stability of social status stemmed from the unchanged dominance-subordinance relations between hens that were members of two flocks.
4. There was some association of higher social status with long-time residence in a given pen when the hens were regrouped.
5. Comparison with the well-known hierarchal behavior of the closely-related common domestic hen revealed no basic differences in the manifestation of social organization.
6. The social organization of Red Jungle Fowl males, assembled in three flocks of thirteen, ten, and ten individuals, respectively, was studied for a combined total of 79.7 hours, extending from February 18, 1952, to October 17, 1953.
7. A social hierarchy based on peck-right dominance relationships was found in each flock.

8. Hierarchal behavior of the male differed from that of the female in the relative lack of stability of dominance-subordinance relationships in the former.
9. Peck-order violations were frequent; twenty complete reversals in dominance were recorded in the male flocks.
10. In addition to pecks and threats, dominance was reflected in the active interference with the crowing of subordinate cocks by their social dominants.
11. Waltzing was a prominent aspect of aggressive behavior in male flock 3 composed of one cock and twelve cockerels, but was infrequently witnessed in adult male groups.
12. Study of the hierarchal behavior of White Leghorn males in conjunction with information in the literature revealed no essential distinction between the Red Jungle and domestic cocks with respect to their social organization.
13. Fifteen hens and sixteen cocks assembled in four heterosexual flocks of Red Jungle Fowl were studied for 82.2 hours between November 4, 1952, and May 20, 1954.
14. The hierarchy in heterosexual flocks consisted of two separate, sex-limited organizations.
15. Males rarely directed aggressive behavior to hens; the reverse was also infrequently witnessed.
16. There was a tendency for females to exhibit less aggressive behavior than males in heterosexual flocks.
17. A positive correlation between high rank in the hierarchy and frequency of mating displays by males was noted.

18. There was no association between status in the female organization and the frequency with which a given hen was courted.
19. The hierarchal behavior of heterosexual flocks of the common domestic fowl was essentially similar to that found in the Red Jungle Fowl.
20. A distinction between the common domestic and Red Jungle Fowl was found with respect to female mating behavior; there is a negative correlation between rank and frequency of being courted in domestic hens, whereas no correlation between these two factors was discernible in the present study of Red Jungle hens.
21. Four tests to determine the extent of territoriality in the subspecies studied revealed a tendency for alpha cocks to exert control over the enclosed area used for the study. However, it was suggested that no generalization be drawn from these data because of the relatively small area used and the fact that subordinate males could not actually be driven out of the yard.
22. A series of thirty staged initial pair-contests between females was conducted. The results of these encounters and the behavior manifested by the contesting jungle hens paralleled that shown by common domestic hens. The adverse effects of handling the birds in daylight forced a discontinuation of the contest series.

23. This report adds to our knowledge of the social organization exhibited by a previously unstudied group. Comparison of the hierarchal behavior of penned flocks of Red Jungle Fowl and the closely-related common domestic fowl revealed no essential distinctions.

APPENDIX

SUMMARY OF FLOCK ORGANIZATION AND STUDY PERIODS

Flock	Flock Type	No. Hours Observed	No. Days Observed	Inclusive Dates of Study	Flock Membership
10A	♀♀	21.0	74	Nov. 24, 1953 to March 22, 1954	30,196,47,160, 189,156,29*,130, 34*
10B	♀♀	18.0	107	June 14, 1954 to Nov. 19, 1954	22,196,322,160, 57,12,210,130, 106,189
23A	♀♀	21.2	65	Aug. 9, 1953 to Nov. 2, 1953	18,20,57,86,2, 12,210,17,321
23B	♀♀	18.1	109	June 15, 1954 to Nov. 23, 1954	18*,20,66,154, 86,158,17,40*, 47,38
3	♂♂	31.7	127	Feb. 18, 1952 to Aug. 12, 1952	1,2,5,3,12,4,8, 6,9,7,10,11,13
24A	♂♂	26.0	89	Nov. 13, 1952 to March 20, 1953	1,3,6,9,14,15, 5,17,18,19
24B	♂♂	22.0	81	June 23, 1953 to Oct. 17, 1953	68,94,21,56,24, 74,97,19,266,1*
21A** 21B** 21C**	♂♂	37.5	151	Nov. 25, 1952 to June 4, 1954	301,313,311,307, 305,302,306,300, 303,314,304,308, 309,312,310
18	♂♀	16.5	66	Nov. 14, 1952 to March 24, 1953	30,33,31,32,50, 52,51
25	♂♀	16.6	67	Jan. 19, 1953 to June 9, 1953	266,244,164,273, 154,236,321,210, 270*
23C	♂♀	25.0	101	Dec. 16, 1953 to May 18, 1954	94,24,244*,154*, 273,83,18,20,236, 65,154,28
24C	♂♀	24.0	96	Dec. 4, 1953 to May 20, 1954	21,266,97,19,74, 57,86,2,12,321, 210

*Died during study period.

**White Leghorn male flocks.

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BIOGRAPHICAL SKETCH

Edwin M. Banks was born March 21, 1926 in Chicago, Illinois. He attended primary and secondary schools in Chicago, and entered the University of Chicago in February 1943. Following a three-year-period of service in the U. S. Navy, he returned to the University of Chicago where he received the Bachelor of Science degree in Zoology in 1949. He continued study in Zoology and received the Master of Science degree in 1950. His research interests were in the field of animal behavior and his work was supervised by the late Dr. W. C. Allee. In 1951, he accepted the position of research assistant to Dr. W. C. Allee, then head of the Department of Biology of the University of Florida, and also continued work toward the Ph.D. degree in Biology, conferred June 1955.

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This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of the committee. It was submitted to the Dean of the College of Arts and Sciences and to the Graduate Council and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

June 6, 1955

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